SCIENTIFIC AMERICAN SUPPLEMENT No 784

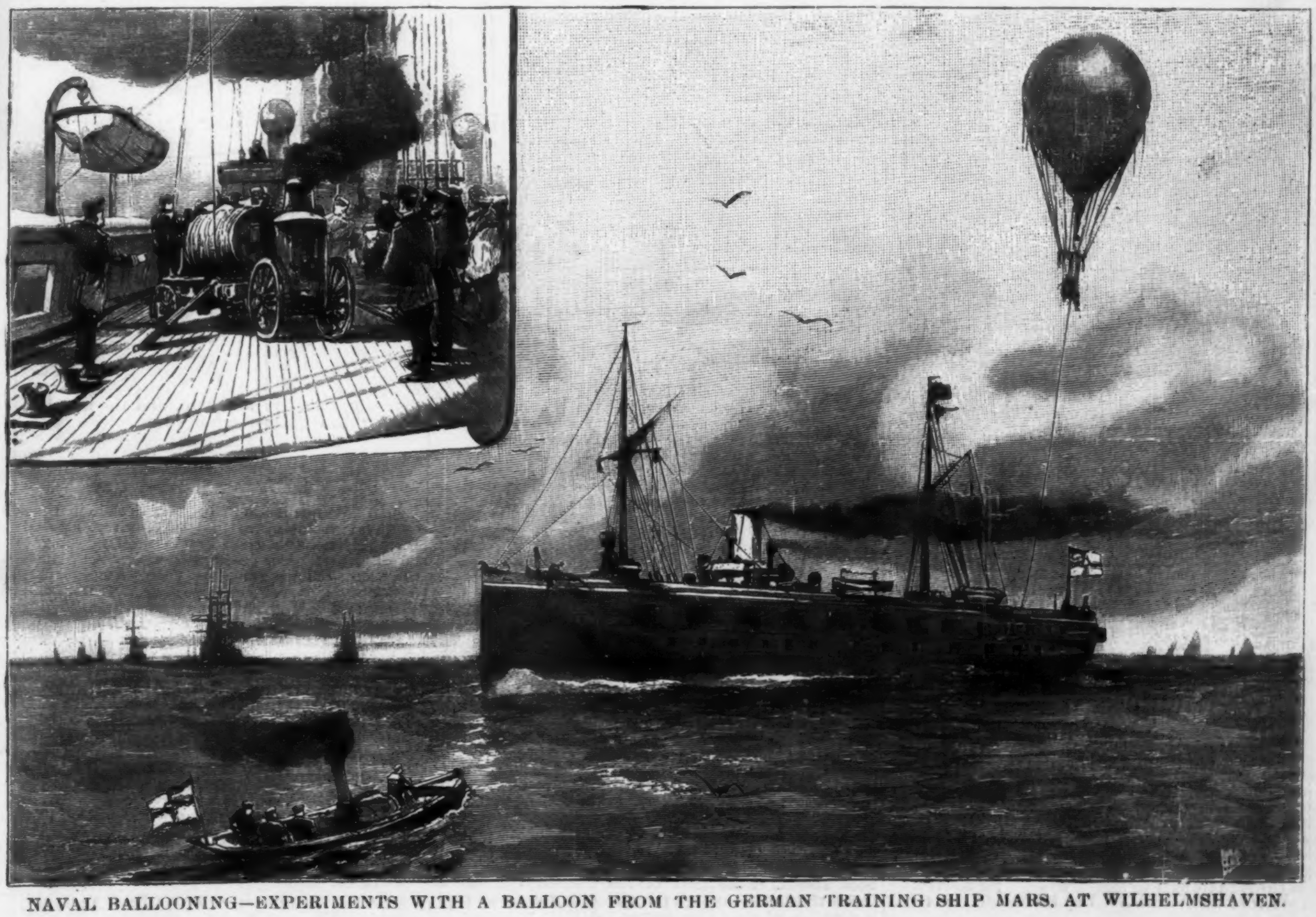
Scientific American Supplement, Vol. XXXI. No. 784.
Scientific American, established 1845.

NEW YORK, JANUARY 10, 1891.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

EXPERIMENTING WITH A CAPTIVE BALLOON.

A CORRESPONDENT of the *Daily Graphic* gives an interesting account of the experiments in marine aeronautics recently made at Wilhelmshaven on board the gunnery ship Mars. A captive balloon was used, with two portable gas generators and a steam drum, on which the balloon cable was wound. The drum was mounted amidships on the upper deck of the Mars, but the balloon was filled on shore and then allowed to float into position above the Mars. The cable was then unwound until the balloon had attained an altitude of about a quarter of a mile. The wind was blowing with a force of between 3 and 4, and this caused the balloon to drift nearly eighty yards from the vertical. Communication between the car and the deck was kept up electrically by means of a core in the cable, and the height attained was found to give an officer in the car a very extensive range of observation. The balloon was afterward sent up as high as 650 yards, and was taken out to sea. Prince Henry of Prussia and Admirals Paschen and Von Parvelsz were present throughout the experiments. Our picture is from a drawing by W. Stower.—*The Graphic.*



NAVAL BALLOONING—EXPERIMENTS WITH A BALLOON FROM THE GERMAN TRAINING SHIP MARS, AT WILHELMSHAVEN.

COMPRESSED AIR FOR POWER DISTRIBUTION.

WITHIN the limits of the city of Dresden the erection of steam boilers is prohibited, and with a view of developing small industries and also supplying electric light, the question of distribution of power has recently attracted considerable attention. Electric distribution naturally suggested itself, but the objections to high-tension currents led to a consideration of compressed air as a means of power distribution. Dr. R. Proell, well known in this country as the designer of the Proell governor, has worked out an elaborate scheme, and in a pamphlet published by himself and Messrs. O. L. Kummer & Co., of Dresden, gives very complete details, both in calculations and drawings, of a project for supplying 7,500 indicated horse power, and he expresses the opinion that a well-designed and carefully arranged installation of this kind would compete in economy with an electric installation involving distribution by cables over long distances. A careful perusal of the pamphlet itself will probably enable the initiated to form a better opinion on this question, and we will confine ourselves to stating the general features of the scheme. Provision is made for the erection of ten triple expansion condensing engines, working with an initial pressure of 150 lb. and twenty-fold expansion of steam, each engine to indicate 750 horse power. The cylinders are to be 18·9 in., 30·7 in., and 49·2 in. in diameter and 49·2 in. stroke, working at 60 revolutions per minute, which gives a piston speed of 490 ft. per minute.

They are arranged horizontally; the flywheel shaft has two cranks, to one of which are connected the intermediate and high-pressure pistons, tandem fashion, and to the other the low-pressure piston and air pump, the latter placed vertically below the foundations. Coupled to the extended piston rods, in each case, is an air compressor. The steam consumption is estimated at from 12·1 lb. to 12·5 lb. per indicated horse power per hour. The air compressors have cylinders 27·5 in. in diameter and 49·2 in. stroke, same as the engines, and while the latter are, of course, controlled by the Proell valve gear of the latest pattern, the air compressors are fitted with mechanically controlled double-beat valves of the Riedler type. The cooling is effected by an external water jacket round the cylinder covers and valve chests, injection being objected to by the designer. The twenty compressor cylinders are calculated to produce 2,200,000 cubic feet of air of 120 lb. pressure per day, crediting the compressors with a coefficient of efficiency of 90 per cent. Steam is to be generated by fifteen water-tube boilers of the "Durr" type, each having 2,200 square feet of heating surface, the fuel is to be lignite, fired into regenerators of the Schneider type, and with this arrangement the author expects to obtain an evaporation of 5 lb. of water per pound of lignite. An interesting automatic regulator is next described and illustrated, which has the object to adapt the air compression to the consumption. It consists of a pressure regulator operated upon by the air in the main, and altering the point of cut-off in the steam cylinder, thus either increasing or decreasing the speed of the engine until equilibrium is again established.

Probably the most novel features of the scheme consist in the motors, which it is intended to erect for the utilization of the compressed air. Heating the air during expansion, and at the same time injecting a water spray, are the leading points. For medium powers of 4 horse power and upward, the author proposes to use the "Doerfel-Proell" engine, of which a considerable number are already in regular use with steam, giving very economical results at from 200 to 300 revolutions. This motor is combined with a coil boiler, in which latter the compressed air is heated before it enters the motor, and during the heating process a small amount of water enters the coil from an overhead reservoir, while the exhaust air is used for accelerating the draught, thus establishing a self-regulating arrengement. For small powers of from ¼ horse power, a new compound single-acting engine has been designed, somewhat of the pattern of the numerous box engines, the two cylinders being arranged on one center line vertically above each other, and the pistons attached to the same crank passing between the two. In these little motors a gas burner is provided under the bottom of low-pressure cylinder to heat the air as it expands in the latter. This heating is of considerable importance, and when completely carried out, the author asserts that air motors can be worked as economically as any other method of power transmission, or producing steam power on a moderate scale. In large engines, however, such as would be necessary to supply electric light for a district, the air-heating appliance would require considerable heating surface, and to obviate this, combined gas and air engines, on the plan of Mr. Fischinger, have been designed by the author, in which the heat of the gas explosion is immediately utilized to warm the compressed air used as motive power in the air cylinder. The two cylinders are arranged horizontally, tandem fashion, the air cylinder nearest the crankshaft. The compressed air enters the jacket of the gas cylinder, which latter is of the two-cycle Benz type, cools this and enters the working cylinder ready heated. That all this has been most elaborately worked out in calculations will be expected by all who know Dr. Proell, and any one sufficiently interested in this scheme will do well to study the pamphlet in question, which moreover contains detailed calculations on the capital to be expended as well as working expenses.—*Engineering.*

AN APPARATUS FOR PROVIDING A STEADY PLATFORM FOR GUNS, ETC., AT SEA.

AT one of the meetings of the Institute of Naval Architects a paper was read by Mr. Beauchamp Tower, on the above subject.

The apparatus he had constructed and tried in practice; it gives a perfectly steady platform on board a ship in a seaway. The *Engineer* says: Fig. 1 is a section through the apparatus, showing the working parts. Fig. 2 is a plan looking down from above on the machine. Fig. 3 is a side view of the machine,

showing generally how it is mounted on the vessel. The central part, on which the gun is mounted, and to which the seat on which the man sits is attached, is the "platform." This is, in fact, the part to be kept steady. This platform is suspended in gimbals on the top of a hopper-shaped pedestal, which stands on a round hollow pillar rising up from the vessel's deck. The part which in ordinary gimbals is usually a ring has, in the present case, two opposite quarters of it cut away so as to form two gaps for the gun, so that the gun may lie exactly in the plane of the gimbals. The remaining quarters of the gimbal ring are connected together rigidly by a half hoop, passing below and clear of the fittings of the platform. These two remaining portions of the gimbal ring are in the form of straight arms, called gimbal arms. These are well shown in Fig. 2.

One end of each arm moves in a bearing attached to the top of the hopper-shaped pedestal, this bearing having all the motions of the ship; the other end forms a bearing in which the platform rests. These arms are made hollow, and the bearings contain water-tight oscillating joints, so that a supply of high pressure water can be sent from a pumping engine through the hollow gimbal arms to the platform, for the purpose of actuating the mechanism.

Projecting down from the platform, and attached to it, are four cylinders, one at each corner; out of the top of each of these cylinders projects a ram or plunger, which works freely, yet water-tight, in a collar at the top of the cylinder; each ram is attached by a connecting rod to the pedestal, and therefore to the ship. Supposing water under pressure to enter any one of the cylinders, it would press the ram out of the cylinder, and so cause the platform to be inclined in the gimbals. There being four cylinders equally spaced round the center, the platform can, if desired, be inclined in any direction by forcing water into one or more of the cylinders. Connected to the bottoms of the cylinder is a cross-shaped frame. In the center of this frame is a cup bearing, which forms the bearing of a heavy cast iron disk wheel, revolving in a horizontal plane on a spherical journal resting in the cup, so that the wheel, while free to revolve, is also free to wabble through a small angle in any direction from the central vertical axis of the platform. The center of gravity of the wheel is placed a small distance below the center of the spherical bearing. The bearing has a hole through its axis to form a passage for conveying high pressure water into a cavity in the center of the wheel.

The presence of high pressure water in this passage diminishes the friction of the bearing, by causing the greater part of the weight of the wheel to be carried on the water pressure; the wheel being made just heavy enough to hold itself down against the water pressure in the bearing. Water is in this manner supplied at a pressure of about 100 lb. per square inch to the central cavity in the wheel, from whence it passes by two radial passages to two small tangential jets, the reaction of the water issuing from which causes the wheel to revolve with a velocity of 400 or 500 revolutions per minute. There is also an axial pipe leading up from the central cavity, and terminating in a jet nozzle ⅜ in. in diameter and truly co-axial with the wheel.

When the wheel is supplied with high pressure water it begins to revolve, owing to the reaction of the tangential jets; if at starting it is not in a horizontal plane it begins to perform a slow conical movement, owing to the fact of its being suspended above its center of gravity, the force of gravity therefore putting on it a couple tending to set it upright, and the wheel continually refusing to obey this couple, but inclining in a plane at right angles to it, after the manner of a gyroscope, and thus causing the slow conical oscillation.

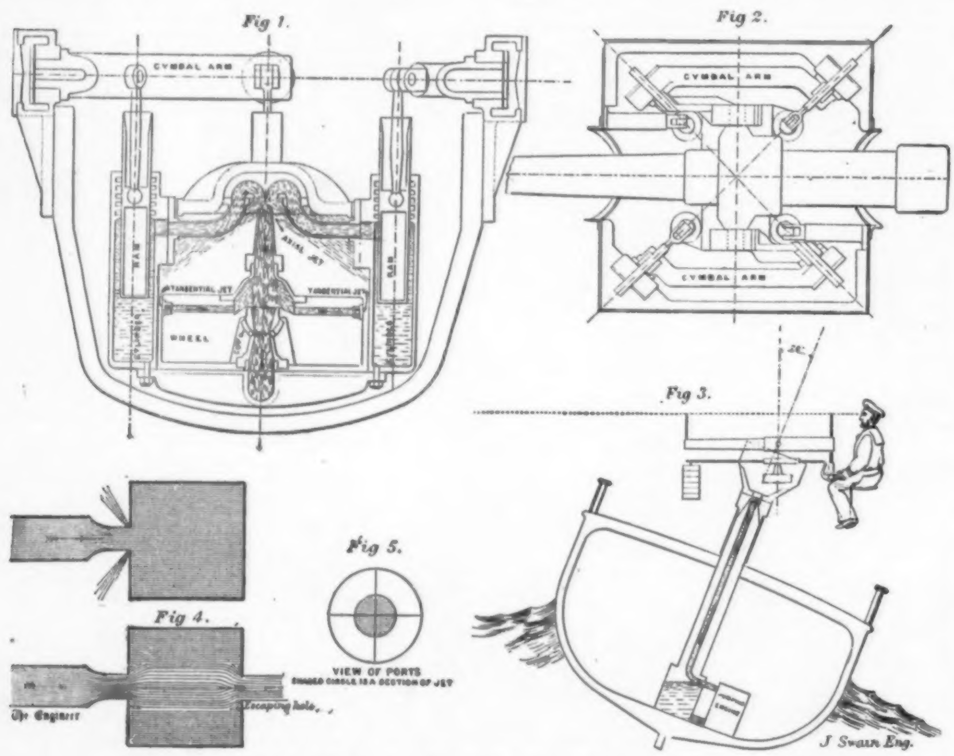
This conical oscillation would continue unabated were it not for the friction of the spherical bearing which extinguishes this motion; and the wheel in a short time after it has started settles down to revolve in a truly horizontal plane with its axis truly vertical, and consequently throws a truly vertical jet out of the axial jet nozzle. Immediately over this vertical ⅜-in. jet, at a short distance from the nozzle, four pipes or passages terminate, with open ends pointing downward. These open ends or ports are brought as closely together as possible; in fact, they are shaped so as to appear as a circle with two narrow bars crossing its center, so as to divide it into four quadrants, each of which is one of the ports—see Fig. 5. Each of these pipes communicates with one of the before mentioned cylinders. The effect of the axial jet is to cause the cylinders to act so as to cant the platform until the center of the axial jet is nearly opposite the center of the circle of ports, that is to say, until the jet is equally distributed over the four ports; for, if it is not in this position, the fact that one port gets more of the jet than another causes the pressure in the cylinder with which that port communicates to be greater than the pressure in the other cylinders, and thus the platform is canted until the jet and the group of ports are concentric. Thus, by means of the cylinders, the platform is resolutely and powerfully held co-axial with the revolving wheel, and, the plane of the wheel being horizontal, the platform is also horizontal. The platform assumes a horizontal attitude in obedience to the direction of the wheel, but at the same time there is no reaction whatever on the wheel tending to disturb it in its horizontal rotation. The wheel acts powerfully on the platform, and yet suffers no reaction on itself.

Whatever force is brought to disturb the horizontality of the platform, none of that force can disturb the horizontality of the wheel, as the wheel only acts on the platform through the jet, and what the jet strikes against after it has left the axial nozzle cannot in any way affect the wheel. It will be observed that the platform must yield slightly to any force tending to disturb its centrality over the wheel, in order that the pressures in the cylinders may be so modified as to balance the disturbing force. The stiffness of the platform, or its power of resisting disturbing forces, can be regulated by varying the proportion between the areas of the cylinders and the length of the axial jet.

There is, however, a limit to the amount of stiffness which can be given, owing to a tendency to oscillate showing itself if the platform is too stiff, but he had been able to make that of the present machine so stable that 300 lb. on a lever one foot long causes an inclination of only one degree. A man weighing 150 lb. can move the center of gravity of his body 6 inches on the seat and only produce an alteration of level of one fourth of a degree. The amount of error caused by the friction of the bearings and other mechanism is only about three quarters of a minute of arc. The man on the seat has under his control a valve governing a hydraulic training cylinder, by which he can turn the whole machine round in azimuth, so as to point in any direction.

The author then explained the theory of the modification of the pressure in the cylinders by the ports being more or less covered by the jet. It is easy for any one familiar with an ordinary Giffard's injector to realize that a high velocity jet can penetrate a hole in a chamber against a considerable pressure. The late Mr. William Froude, in his address to the mechanical section of the British Association in 1875, showed that a jet of water issuing from a vessel under pressure, if received through a hole of its own diameter in another vessel, would very nearly reproduce in the receiving vessel its originating pressure—see Fig. 4. If there is no outlet from the receiving vessel, the water of the jet is spilled at the receiving orifice, as the receiving vessel is full and will hold no more. If there is an outlet of the same size as the jet, the whole of the water will issue through it with the same velocity as the jet, and the pressure will be unaltered. But if this outlet is made larger than the jet, the pressure will be diminished until it is no more than sufficient to give the water the diminished velocity proper to the enlarged orifice. Thus we can vary the pressure in the receiving vessel at will, from nothing up to nearly the original pressure of the jet, by varying the relative proportions of the escaping hole and jet. Now, he considered that if a hole is only partly covered by a jet, that part which is covered must be regarded as a receiving hole, and the uncovered part must be regarded as an escaping hole. The relative areas of these and the resulting pressures are, of course, rapidly varied by any motion of the jet.

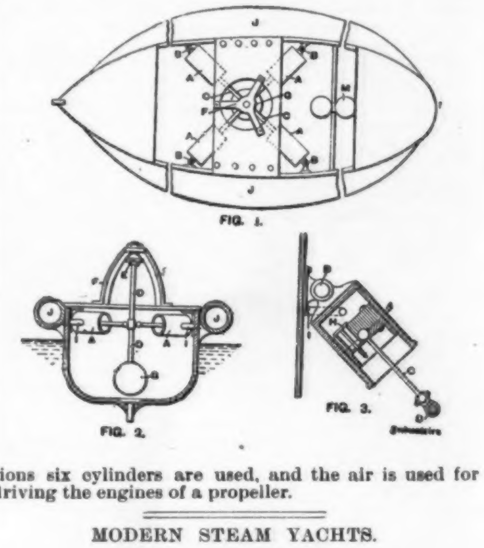
The water used in working the apparatus is about fifty gallons per minute. This water, after issuing from the jets under a pressure of 100 lb. per sq. inch, falls into the hopper-shaped pedestal, and down the hollow column into a tank, from which the steam pump takes its suction.



TOWER'S STEADY PLATFORM FOR GUNS AT SEA.

PROPULSION BY WAVE POWER.

THE annexed illustrations show this invention, by M. T. Neale, London, applied to a lifeboat, the air receivers forcing the buoyant sides of the boat to prevent her heeling over, and also enabling her to right herself after a sudden lurch. Fig. 1 is a plan, and Fig. 2 a section of a boat with four cylinders, A A A A, jointed to straps, B B B B, on the inside of the boat, the piston rods, C C C C, being jointed to a rod, D, suspended by a ball or universal joint, E, from the arch or strap, F. G is the bob or weight at the lower end of the rod, D, which is free to swing in every direction due to the wave motion of the boat, the pistons being actuated in the cylinders by the motion caused by the tendency of the rod, B, to remain perpendicular. Each piston is provided with a valve, H (see sectional view, Fig. 3), which opens as the piston moves inward, and closes when the piston moves outward to compress the air and force it through the flexible tube, I, into the receiver, J, the outlet having a flap or other valve to prevent the return of the air therefrom. In modifications six cylinders are used, and the air is used for driving the engines of a propeller.



MODERN STEAM YACHTS.

By FRED A. BALLIN, N.A.

THE advance made in the last decade in the science of naval architecture in this country, as well as in Europe, has had a great influence on the success of our latest yachts. For years past, ever since the event of the victory of the schooner yacht America in 1851, in a race of the Royal Yacht Squadron around the Isle of Wight in England, this country has had the supremacy in the building of fast sailing boats, but only during the last ten years have our steam yachts commenced to hold their own and surpass the European craft in swiftness, comfort and elegance.

This is mainly due to the perfection which modern marine engineering has attained. The Atalanta, Electra, Stiletto, and the many hundred others, ranging from the fifty foot steam launch to the size of an Atlantic steamer, in speed from twelve to twenty-five miles an hour, are no happy accidents, but the result of skill, science and practical experience. To give the reader an idea of this, I will say a few words in regard to the shape of hulls, the more interesting as there is not a captain, mate, or deckhand aboard of any steamer that has not the conviction within himself that he knows almost to a certainty how a boat ought to be shaped. Nothing is more erroneous than to assume that models of modern ships are whittled out by guess, while actually to-day the principles of resistances to the locomotion of vessels are too well understood to be left to chances by naval architects. It is true that a great number of boats and especially yachts are designed by unprofessional men, generally carpenters, or yachtsmen, and the many failures to come up to the expectation are too often put down as lack of science, while they ought to be laid to the lack of proper application of science. In New York and other Eastern cities naval architecture is recognized as a profession in itself, while around the lakes, outside the largest ship yards, builder and designer is generally the same man. The educated man when he gets sick sends to the doctor for a prescription and has this made up in a drug store; the uneducated goes to the drug store, saves his doctor bill, very often to his own sorrow. A similar practice prevails in boat building in regard to architect and builder.

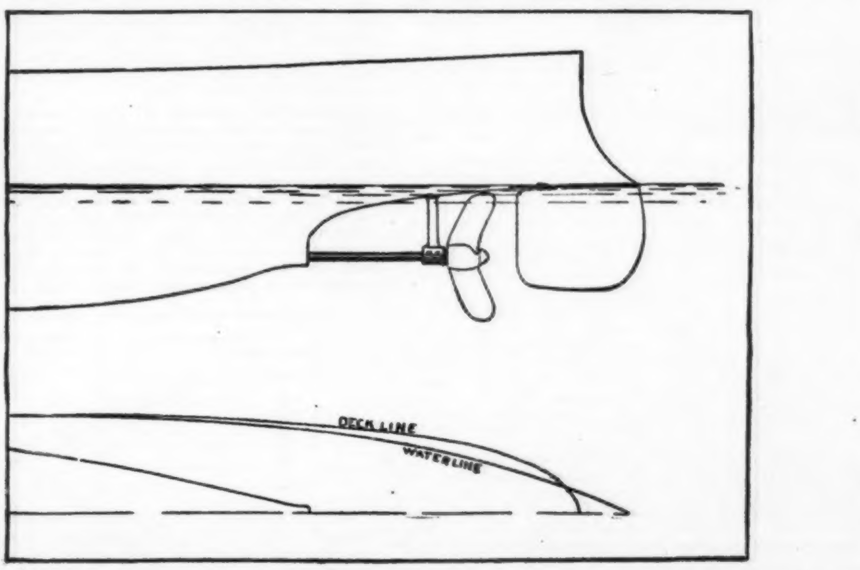
In designing the shape of a boat, preliminary calculations have to be made to accurately determine weight, trim and draught. These items depend on size of boat, purpose and speed. It would lead too far to go into details in this article as to how this is done. I only want to state that after weight has been settled on, the lines and shape are laid down. Weight and displacement are functions of each other, and for the uninformed I may state that the amount of water displaced by the hull of any boat, in pounds, is equal to the weight of the boat out of water in pounds.

Experiments on boats and models made by Scott Russell, Froude, Burgess and others have proved con-

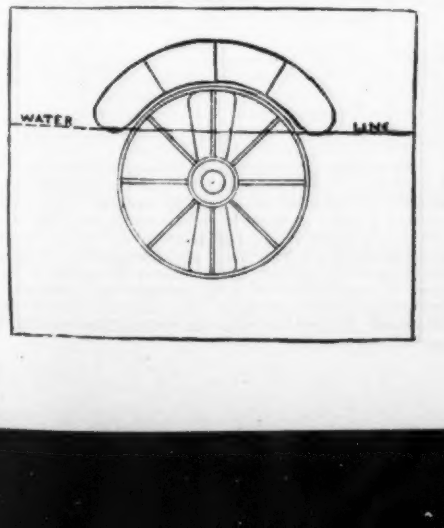
clusively that the principal resistance to a moving object through water is that caused by the friction of the water on the surface, and the amount of this for boats of equal length and beam, and good but different models, does not vary perceptibly per square foot of surface, provided the condition of the surfaces are the same. The amount of this resistance is from 70 to 80 per cent. of the aggregate resistance, while the balance is wave, eddy, or whirl resistances. These latter are larger in full and short boats, but get smaller the larger the proportion of length to beam. The friction being the largest item of resistance, we will investigate it closer. In designing a boat for speed only, it will be understood that the smaller the surface with the largest amount of displacement, the less will be the friction, and as the circle is known to contain the largest area with the smallest circumference, it will be easy to concede that a shape of hull whose frames approach nearest to a circle will be the one best adapted.

This theory is carried out in practice, and we find all fast torpedo boats, yachts, etc., built with round bottoms. The initial stability of such a hull is, however, such that, without proper stowing of the outfit and machinery, the boats would not stand up, inasmuch as the metacentrum would lie at the center of circle, and there would not be righting momentum. In practice it was, therefore, necessary to compromise, and, while still retaining the roundness of bottom, flare out the frame at and above the water line, which increases the immerged and decreases the emmerged section in rolling of the boat and so increases the stability by reason of additional buoyancy of the immersed section of hull. The same principle governing the shape of the cross sections holds good in regard to those of the longitudinal lines. Scott Russell, the inaugurator and defender of the hollow water line (sinoids), greatly overestimated the wave-forming resistance, which he tried to overcome by shaping the lines to conform with those of supposed waves, but since the increased length of a hollow line increases also the amount of surface, and hence the friction, there is more added than gained. Another advantage of the straight or convex lines over a hollow or concave line lies in the fact that the mean angle of the water, in following the outside contour of the boat, is considerably smaller, that there is no reverse motion or deviation of the water course. A prevailing idea is that the water runs around a boat in a parallel plane; this is not the case, except in very narrow, deep boats, while in the average shaped boat the water runs in lines lying between section and water lines. The water being denser below than above, it will have an upward motion at the stern, the resultant of the side pressure, the forward motion, caused and retarded by the friction and the buoyancy of the water seeking its level.

This tendency of the water at the stern to rise vertically must be guarded against by a proper shaped hull. For moderate speed and very large, long boats, a rather full, quick flaring shape of stern frames counteracts this, but small boats running faster than their specific speed will generally show the water rise to their fender. This defect is called squatting, and to overcome it has for a long time puzzled marine architects. Thornycroft and Yarrow, in England, were the first men who succeeded in building small torpedo boats of a speed of over twenty miles an hour that did not show any sternwave by virtually dropping the fantail down to the level of the water. The sketch below will illustrate this better than a description.

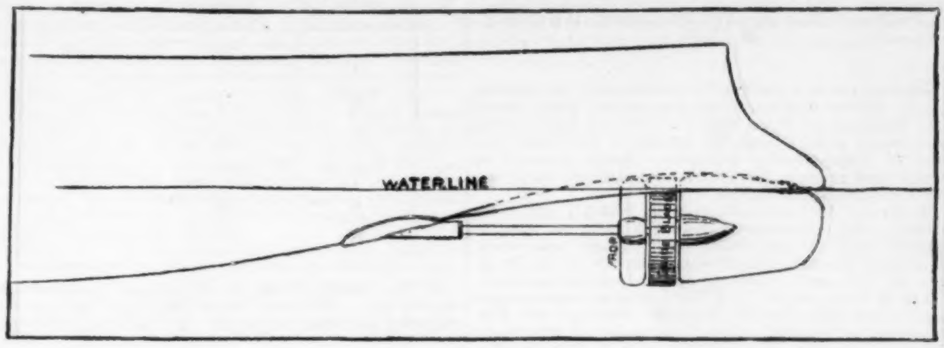


Thornycroft went even further, and by the invention of his guide blade propeller was enabled to drop the fantail over the screw, inclosing the latter in a cove and letting it project above the waterline underneath. A section at the wheel was thus:



And a side view aft something like the cut below.

The object of this construction, besides preventing the boat from squatting, was to convert the centripedal force of the water around the wheel into a direct fore and aft motion. In the application of his theories Mr. Thornycroft has been very successful, and his



guide blade propeller has been reduced in size and increased in efficiency to such an extent that it shows all the advantages of the paddle wheels without their incumbrances.

The question of screw propulsion for shallow water has been widely discussed, and in most cases, where the draught is counted by inches, the screw is dismissed as impracticable. Most architects are at a loss to answer inquiries from people who want a boat on a certain route, where the draught is limited, and, as a rule, where they do not like side wheels for obvious reasons, and if the successes of Mr. Thornycroft were only widely known, apparent impossibilities would often be overcome. I believe it to be of interest to mention a boat built by this gentleman for a firm in Egypt. There on the Nile depth of water is continually varying, and the boat he built only drew 15 inches of water. She was 56 feet 8 inches long, 7 feet 8 inches beam, and attained a speed of over 20 miles an hour. The propeller had a diameter of 20 inches, and through this the engine exerted, on trial, 103 indicated horse power. The machinery consisted of two ordinary high pressure engines 6½ inches by 8 inches stroke, making 528 revolutions per minute with 150 pounds of steam. The boiler was of the locomotive type, and had 6·7 sq. feet of grate surface and 24·4 square feet of heating surface. The displacement of the boat was only 6·7 tons fully equipped with fuel and fourteen men. If the power had been applied to an ordinary stern propeller we doubt whether the speed had exceeded 14 miles, while this boat only drawing 15 inches of water skimmed the surface at a rate of 20.

On our lakes the demand for low draught, speedy boats is very frequent, and at the next chance I have made up my mind to copy Thornycroft and his invention.

The first man in this country to profit by Yarrow and Thornycroft's success was Herreshoff, and the Stiletto, the Now Then, Say When, and Cushing are proofs of this.

Before leaving this subject of frictional resistance, I wish to say that experiments made by Froude show that at a speed of 600 feet per minute the friction on a surface of painted iron or steel over 50 feet long per square foot was 0·25 pound, while with an equal surface of 8 feet length the friction was 0·325, or 33 per cent. more. This shows that the shorter the boat, the larger the friction. Explained is this fact by the large proportion absorbed by the entering edge and its percentage to the whole; it teaches the importance of giving our boats an easy and sharp entrance at the stem.

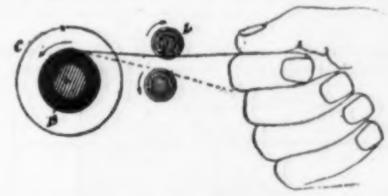
I mentioned above that every boat has a specific speed. Under this I understand taking boats of equal model, but different lengths, that speed attained by a boat without waste of power.

The idea of speed and proportional power is only understood by a few. While a yacht is mostly built for comfort, very often a large beam is chosen, which to a great extent influences speed. As a rule, if a boat has less than seven times the beam in length, it requires more power than if she is longer. For instance, a boat 100 feet long on water line ought not to have over 14 feet beam for speed. Sometimes estimates of speed and cost of boat are given and are met with the decision from the would-be buyer that if we add two miles to speed he will be satisfied, and we may go on with the work. Now this man does not know how unreasonable his demand is. He acts *bona fide* in supposing that if a boat is guaranteed to run ten miles an hour, the extra two miles add only one-fifth to the power, but there he is mistaken.

Supposing the boat to have proper proportions of length and beam and good, fair lines, and a coefficient of displacement of about 55 per cent., the ratio of power is like the square of the speed, or, in this case, as 100 is to 144. In other words, it requires 50 per cent. more power to drive the boat two miles an hour faster, which means engine and boiler one and one-half times the size figured on in the first place, besides the allowance that has to be made for extra weight and displacement.—*Marine Record.*

WOOD'S MAGNET WINDER.

A CLEVER little device is described in the *Electrical Engineer*, of New York, by which a wire may be easily guided to and fro in winding magnet coils. Two guide spindles, L, are geared together and to the sleeve, B, on which the bobbin, C, is carried. The spindles have screw threads cut on them, and as they revolve in opposite directions, a wire guided by any thread is carried laterally in one direction or in the other. The

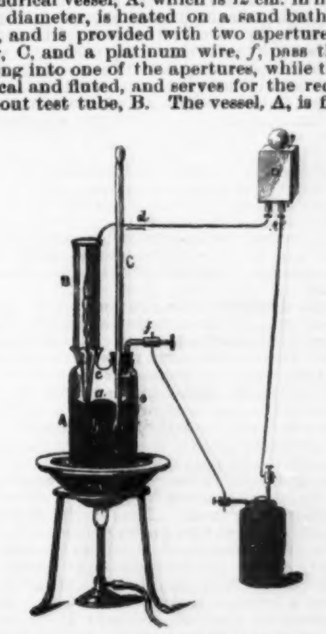


operator has only to move his hand up or down to engage the wire in one screw thread or in the other. The speed of the guide spindles must be proportioned to the gauge of the wire. The difficulty in winding a magnet chiefly is met with at the ends rather than in guiding the wire, as every young electrician knows, but this method may sometimes prove to be useful.

ELECTRICAL DEVICE FOR DETERMINING MELTING POINTS.

THE apparatus shown in the accompanying sketch is due to the ingenuity of A. C. Christomanos, who gives an elaborate description of it in the *Berichte der Deutschen Chemischen Gesellschaft*. He claims that by means of it a more correct determination of the melting point of substances can be insured.

The essential features of this apparatus are as follows: The cylindrical vessel, A, which is 12 cm. in height and 6 cm. in diameter, is heated on a sand bath or in an air bath, and is provided with two apertures; a thermometer, C, and a platinum wire, *f*, pass through a cork fitting into one of the apertures, while the other, *c*, is conical and fluted, and serves for the reception of a drawn out test tube, B. The vessel, A, is filled with



pure mercury to such a depth that the end, *b*, of the test tube is about 2 cm. below the surface, *a o*, of the metal.

The substance is introduced in a melted condition into the end, *b*, of the drawn-out test tube, so that it forms a layer of from 0·5 to 1·5 cm. in length, and when it has completely solidified again the test tube is placed in position, and the space, *a c*, immediately above the substance filled with mercury, into which dips the platinum wire, *d*.

On applying heat, the mercury in A is uniformly heated throughout its whole mass, so that the thermometer and the substance are always at the same temperature; the moment the substance melts the two

mercury columns come in contact, the circuit is completed, the bell, D, rings, and the temperature is noted.

[Continued from SUPPLEMENT, No. 781, page 12479.]

THE ELECTROMAGNET.*

By Professor SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

II.

WE are now in a position to understand the bearing of some curious and important researches made about forty years ago by Dr. Julius Dub, which, like a great many other good things, lie buried in the back volumes of Poggendorff's *Annalen*. Some account of them is also given in Dr. Dub's now obsolete book, entitled *Elektromagnetismus*.

The first of Dub's experiments to which I will refer relates to the difference in behavior between electromagnets with flat and those with pointed pole ends. He formed two cylindrical cores, each six inches long, from the same rod of soft iron, one inch in diameter. Either of these could be slipped into an appropriate magnetizing coil. One of them had the end left flat, the other had its end pointed, or, rather, it was coned down until the flat end was left only ½ inch in diameter, possessing therefore only one fourth of the amount of contact surface which the other core possessed. As an armature there was used another piece of the same soft iron rod, twelve inches long.

The pull of the electromagnet on the armature at different distances was carefully measured, with the following results:

Distance apart in inches.	Pull on Flat Pole (lb.)	Pull on Pointed Pole (lb.)
0	3·3	5·2
0·0055	1·1	1·8
0·0110	0·9	0·75
0·0165	0·71	0·50
0·022	0·60	0·42
0·044	0·38	0·20
0·088	0·19	0·09

These results are plotted out in the curves in Fig. 35. It will be seen that in contact, and at very short

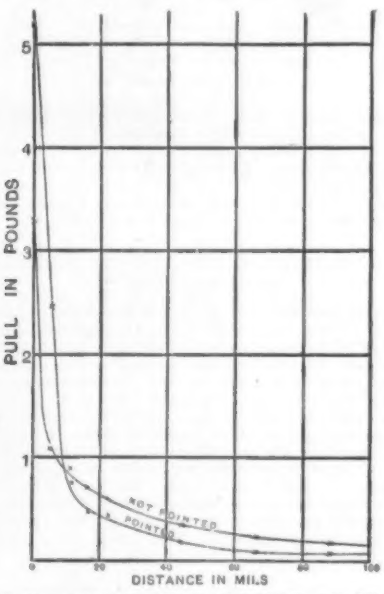


FIG. 35.—CONTRASTED EFFECT OF FLAT AND POINTED POLES.

distances, the reduced pole gave the greater pull. At about ten mils distance there was equality, but at all distances greater than ten mils the flat pole had the advantage.

At small distances the concentration of magnetic lines gave, in accordance with the law of traction, the advantage to the reduced pole. But this advantage was, at the greater distances, more than outweighed by the fact that with the greater widths of air gap the use of the pole with larger face reduced the magnetic reluctance of the gap and promoted a larger flow of magnetic lines into the end of the armature.

Dub's next experiments relate to the employment of polar extensions or pole pieces attached to the core. These experiments are so curious, so unexpected, unless you know the reasons why, that I invite your especial attention to them. If an engineer had to make a firm joint between two pieces of metal, and he feared that a mere attachment of one to the other was not adequately strong, his first and most natural impulse is to enlarge the parts that come together—to give one as it were a broader footing against the other. And that is precisely what an engineer, if uninstructed in the true principles of magnetism, would do in order to make an electromagnet stick more tightly on to its armature. He would enlarge the ends of one or both. He would add pole pieces to give the armature a better foothold. Nothing, as you will see, could be more disastrous.

Dub employed in these experiments a straight electromagnet having a cylindrical soft iron core, one inch in diameter, twelve inches long, and as armature a piece of the same iron, six inches long. Both were flat ended. Then six pieces of soft iron were prepared of various sizes, to serve as pole pieces. They could be screwed on at will either to the end of the magnet core or to that of the armature. To distinguish them, we will call them by the letters A, B, C, etc. Their dimensions were as follows, the inches being presumably Bavarian inches:

Piece.	Diameter.	Length.
	inches.	inches.
A	2	1
B	1¾	1¼
C	1⅝	2
D	2	½
E	1¼	1
F	1	2

Of the results obtained with these pieces we will select eight. They are those illustrated by the eight collected sketches in Fig. 36. The pull required to detach was measured, also the attraction exerted at a certain distance apart.

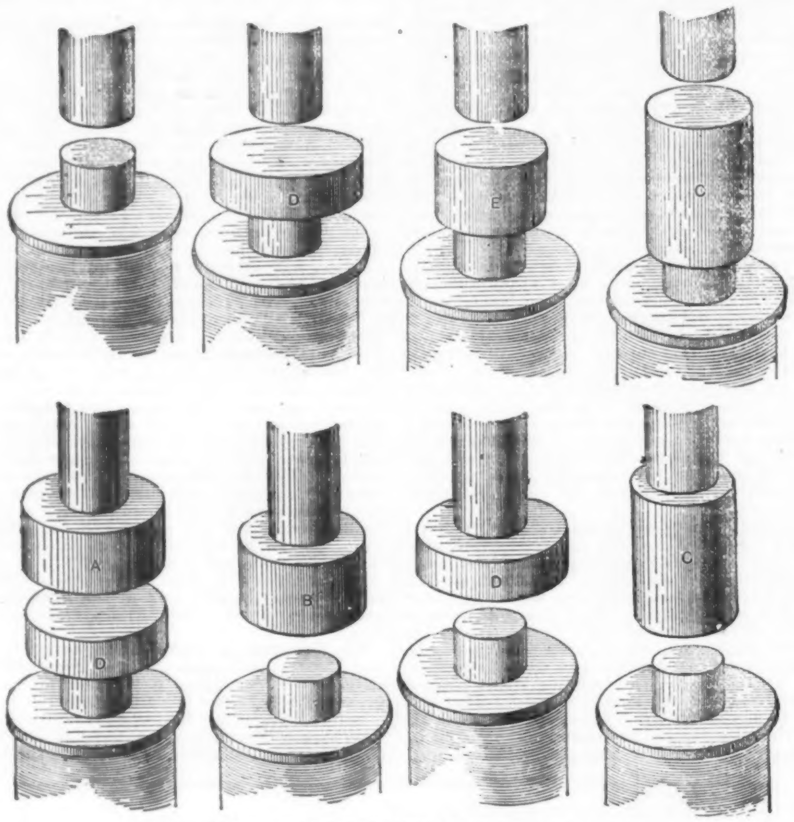


FIG. 36.—DUB'S EXPERIMENTS WITH POLE PIECES.

Experiment.	On Magnet.	On Armature.	Traction.	Attraction.
I.	none	none	48	22
II.	D	none	30	10
III.	E	none	32	11·5
IV.	C	none	35	13·5
V.	D	A	20	7·5
VI.	none	B	50	23
VII.	none	D	43	25
VIII.	none	C	50	18

It will be noted that, in every case, putting on a pole piece to the end of the magnet diminished both the pull in contact and the attraction at a distance. It simply promoted leakage and dissipation of the magnetic lines. The worst case of all was that in which there were pole pieces both on the magnet and on the armature. In the last three cases the pull was increased, but here the enlarged piece was attached to the armature, so that it helped those magnetic lines which came up into it to flow back laterally to the bottom end of the electromagnet; while thus reducing the magnetic reluctance of the return path through the air, and so increasing the total number of magnetic lines, it did not spread unduly those that issued up from the end of the core.

Pole-piece used.	Deflexion (degrees).
none	34·5
A	42
B	41·5
C	40·5
D	41
E	39
F	38

The next of Dub's results relate to the effect of adding these pole pieces to an electromagnet twelve inches long, which was being employed, broadside on, to deflect a distant compass needle (Fig. 37).

In another set of experiments of the same order a permanent magnet of steel, having poles, n s, was slung horizontally by a bifilar suspension, to give it a strong tendency to set in a particular direction. At a short distance laterally was fixed the same bar electromagnet, and the same pole pieces were again employed. The results of attaching the pole pieces at the rear end are not very conclusive. They slightly increased the deflection. But in the absence of information as to the distance between the steel magnet and the electromagnet, it is difficult to assign proper values to all the causes at work. The results were:

FIG. 37.—DUB'S DEFLECTION EXPERIMENT.

Pole-piece used.	Deflexion (degrees).
none	8·5
A	9·2
B	9·5
C	10
D	8·8

When, however, the pole pieces were attached to the distant end of the electromagnet, where their effect would undoubtedly be to promote the leakage of magnetic lines into the air at the front end without much affecting the distribution of those lines in the space in front of the pole, the action was more marked.

Pole-piece used.	Deflexion (degrees).
none	8·5
A	10·0
B	10·3
C	10·3
D	10·1

Still confining ourselves to straight electromagnets, I now invite your attention to some experiments made in 1862 by the late Count Du Moncel as to the effect of adding a polar expansion to the iron core. He used as his core a small iron tube, the end of which he could close up with an iron plug, and around which he placed an iron ring which fitted closely on to the pole. He used a special lever arrangement to measure the attraction exercised upon an armature distant in all cases one millimeter from the pole. The results were as follows:

* Lectures delivered before the Society of Arts, London, 1890. From the Journal of the Society.

	Without ring on pole.	With ring on pole.
Tubular core alone	11	10
ditto, with iron plug	17	14
Core provided with mass of iron at distant end	27	25
ditto, ditto, with iron plug	38	33

After hunting up these researches, it was extremely interesting to find that so important a fact had not escaped the observant eye of the original inventor of the electromagnet. In Sturgeon's "Experimental Researches" (p. 113) there is a foot note, written about the year 1832, which runs as follows:

"An electromagnet of the above description, weighing three ounces, and furnished with one coil of wire, supported fourteen pounds. The poles were afterward made to expose a larger surface by welding to each end of the cylindric bar a square piece of good soft iron. With this alteration only the lifting power was reduced to about five pounds, although the magnet was annealed as much as possible."

We saw that this straight electromagnet, whether used broadside on or end on, could act on the compass

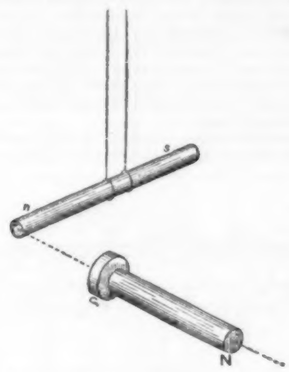


FIG. 38.—DEFLECTING A STEEL MAGNET HAVING BIFILAR SUSPENSION, POLE PIECE ON NEAR END.

needle at some distance from it, and deflect it. In those experiments there was no return path for the magnetic lines that flowed through the iron core save that afforded by the surrounding air. The lines flowed round in wide-sweeping curves from one end to the other, as in Fig. 26, the magnetic field being quite extensive. Now, what will happen if we provide a return path? Suppose I surround the electromagnet with an iron tube of the same length as itself, the lines will flow along in one direction through the core, and will find an easy path back along the outside of the coil. Will the magnet thus jacketed pull more powerfully or less on that little suspended magnet? I should expect it to pull less powerfully, for if the magnetic lines have a good return path here through the iron tube, why should they force themselves in such a quantity to a distance through air in order to get home? No; they will naturally return short back from the end of the core into the tubular iron jacket. That is to say, the action at a distance ought to be diminished by putting on that iron tube outside. Here is the experiment set up. And you see that when I turn on the current my indicating needle is scarcely affected at all. The iron jacket causes that magnet to have much *less* action at a distance. Yet I have known people who actually

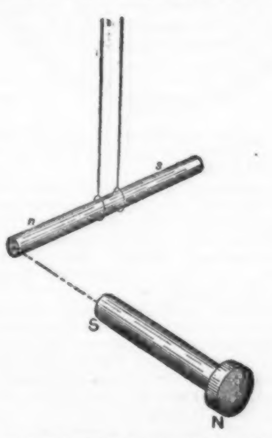


FIG. 39.—DEFLECTING STEEL MAGNET, POLE PIECE ON DISTANT END.

proposed to use jacketed magnets of this sort in telegraph instruments, and in electric motors, on the ground that they give a bigger pull. You have seen that they produce less action at a distance across air, but there yet remains the question whether they give a bigger pull in contact. Yes; undoubtedly they do; because everything that is helping the magnetism to get round to the other end increases the goodness of the magnetic circuit, and, therefore, increases the total magnetic flux.

We will try this experiment upon another piece of apparatus, one which has been used for some years at the Finsbury Technical College. It consists of a straight electromagnet set upright in a base board, over which is erected a light gallows of wood. Across the frame of the gallows goes a winch, on the axle of which is a small pulley with a cord knotted to it. To the lower end of the cord is hung a common spring balance, from the hook of which depends a small horizontal disk of iron to act as an armature. By means of the winch I lower this disk down to the top of the electromagnet. The current is turned on, the disk is attracted. On winding up the winch I increase the upward pull until the disk is detached. See, it required about 9 lb. to pull it off. I now slip over the electromagnet, without in any way attaching it, this loose jacket of iron—a tube, the upper end of which stands flush with the upper polar surface. Once more I lower the disk, and this time it attaches itself at its middle to the central pole, and at its edges to the tube. What force will now be required to detach it? The tube weighs about ½ lb., and it is not fixed at the bottom. Will 9½ lb. suffice to lift the disk? By no means. My balance only measures up to 24 lb., and even that pull will not suffice to detach the disk. I know of one case where the pull of the straight core was increased sixteenfold by the mere addition of a good return path of iron to complete the magnetic circuit.

It is curious how often the use of a tubular jacket to an electromagnet has been reinvented. It dates back to about 1850, and has been variously claimed for Romershausen, for Guillemin, and for Fabre. It is described in Davis' "Magnetism," published in Boston in 1855. About 16 years ago Mr. Faulkner, of Manchester, revived it, under the name of the *Altandae* electromagnet. A discussion upon jacketed electromagnets took place in 1876, at the Society of Telegraph Engineers; and in the same year Professor Graham Bell used the same form of electromagnet in the receiver of the telephone which he exhibited at the Centennial Exhibition. But the jacketed form is not good for anything except increasing the tractive power. Jacketing an electromagnet which already possesses a return circuit of iron is an absurdity. For this reason the proposal made by one inventor to put iron tubes outside the coils of a horseshoe electromagnet is one to be avoided.

We will take another paradox, which equally can be explained by the principle of the magnetic circuit. Suppose you take an iron tube as an interior core; suppose you cut a little piece off the end of it, a mere ring of the same size. Take that little piece and lay it down on the end. It will be struck with a certain amount of pull. It will pull off easily. Take that same round piece of iron, put it on edgewise, where it only touches one point of the circumference, and it will stick on a good deal tighter, because it is there in a position to increase the magnetic flow of the magnetic lines. By concentrating the flow of magnetic lines over a small surface of contact increases $\mathbf{B}$ at that point, and $\mathbf{B}^2$, integrated over the lesser area of the contact, gives a total bigger pull than is the case when the edge is touched all round against the edge of the tube.

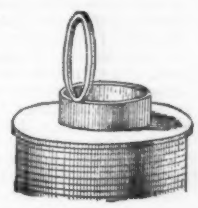


FIG. 40.—EXPERIMENT WITH TUBULAR CORE AND IRON RING.

Here is a still more curious experiment. I use a cylindrical electromagnet set upon end, the core of which has at the top a flat circular polar surface about two inches in diameter. I now take a round disk of thin iron—ferrotype or tin plate will answer quite well—which is a little smaller than the polar face. What will happen when this disk is laid down flat and centrally on the polar face? Of course you will say that it will stick tightly on. If it does so, the magnetic lines which come in through its under surface will pass through it and come out on its upper surface in large quantities. It is clear that they cannot all, or even any considerable proportion of them, emerge sideways through the edges of the thin disk, for there is not substance enough in the disk to carry so many magnetic lines. As a matter of fact the magnetic lines do come through the disk, and emerge on its upper surface, making indeed a magnetic field over its upper surface that is nearly as intense as the magnetic field beneath its under surface. If the two magnetic fields were exactly of equal strength, the disk ought not to be attracted either way. Well, what is the fact? The fact, as you see now that the current has been turned on, is that the disk absolutely refuses to lie down on the top of the pole. If I hold it down with my finger, it actually bends itself up, and requires force to keep it down. I lift my finger and over it flies. It will go anywhere in its effort to better the magnetic circuit rather than lie flat on the top of the pole.

Next I invite your attention to some experiments, originally due to Von Koike, published in the "Annalen" forty years ago, respecting the distribution of the magnetic lines where they emerge from the polar surface of an electromagnet. I cannot enumerate them all, but will merely illustrate them by a single example. Here is a straight electromagnet with a cylindrical, flat-ended core (Fig. 41). In what way will the magnetic lines be distributed over at the end? Fig. 41 illustrates roughly the way in which, when there is no return path of iron, the magnetic lines leak through the air. The main leakage is through the ends, though there are some at the sides also. Now the question of the end distribution we shall try by using a small bullet of iron, which will be placed at different points from the middle to the edge, a spring balance being employed to measure the force required to detach it. The pull at the edge is much stronger than at the middle, at least four or five times as great. There is a regular increase of pull from the middle to the edge.

The magnetic lines, in trying to complete their own circuit, flow most numerously in that direction where they can go furthest through iron on their journey. They leak out more strongly at all edges and corners of a polar surface. They do not flow out so strongly at the middle of the end surface, otherwise they would have to go through a larger air circuit to get back home. The iron is consequently more saturated round the edge than at the middle; therefore, with a very small magnetizing force, there is a great disproportion between pull at the middle and that at the edges. With a very large magnetizing force you do not get the same disproportion, because if the edge is already far saturated you cannot by applying higher magnetizing power increase its magnetization much, but you can still force more lines through the middle. The consequence is, if you plot out the results of a succession of

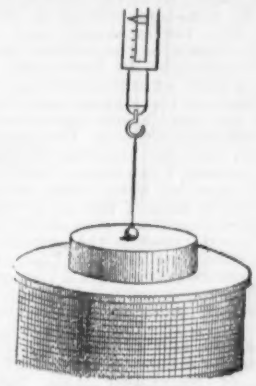


FIG. 41.—EXPLORING POLAR DISTRIBUTION WITH SMALL IRON BALL.

experiments of the pull at different points, the curves obtained are, with larger magnetizing forces, more nearly straight than are those obtained with small magnetizing forces. I have known cases where the pull at the edge was six or seven times as great as in the middle with a small magnetizing power, but with larger power not more than two or three times as great, although, of course, the pull all over was greater. You can easily observe this distribution by merely putting a polished iron ball upon the end of the electro-magnet, as in Fig. 42. The ball at once rolls to the edge and will not

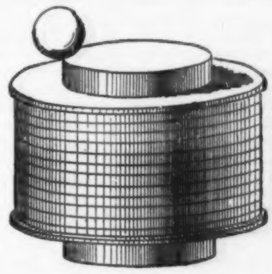


FIG. 42.—IRON BALL ATTRACTED TO EDGE OF POLAR FACE.

stay at the middle. If I take a larger two-pole electromagnet (like Fig. 11), what will the case now be? Clearly the shortest path of the magnetic lines through the air is the path just across from the edge of one polar surface to the edge of the other between the poles. The lines are most dense in the region where they arch over in as short an arch as possible, and they will be less dense along the longer paths, which arch more widely over. Therefore, as there is a greater tendency to leak from the inner edge of one pole to the inner edge of the other, and less tendency to leak from the outer edge of one to the outer edge of the other, the biggest pull ought to be on the inner edges of the pole. We will now try it. On putting the iron ball anywhere on the pole it immediately rolls until it stands perpendicularly over the inner edge.

The magnetic behavior of little iron balls is very curious. A small round piece of iron does not tend to move at all in the most powerful magnetic field if that magnetic field is uniform. All that a small ball of iron tends to do is to move from a place where the magnetic field is weak to a place where the magnetic field is strong. Upon that fact depends the construction of several important instruments, and also certain pieces of electromagnetic mechanism.

In order to study this question of leakage, and the relation of leakage to pull, still more incisively, I devised some time ago a small experiment with which a group of my students at the Technical College have been diligently experimenting. Here (Fig. 43) is a

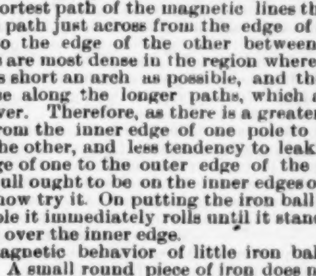


FIG. 43.—EXPERIMENT ON LEAKAGE OF ELECTROMAGNET.

horseshoe electromagnet. The core is of soft wrought iron, wound with a known number of turns of wire. It is provided with an armature. We have also wound on three little exploring coils, each consisting of five turns of wire only, one, C, right down at the bottom,

on the bend; another, B, right round the pole close up to the armature; and a third, A, around the middle of the armature. The object of these is to ascertain how much of the magnetism which was created in the core by magnetizing power of these coils ever got into the armature. If the armature is at a considerable distance away, there is naturally a great deal of leakage. The coil, C, around the bend at the bottom is to catch all the magnetic lines that go through the iron; the coil, B, at the poles, is to catch all that have not leaked outside before the magnetism has crossed the joint; while the coil, A, right around the middle of the armature, catches all the lines that actually pass into the armature, and pull at it. We measure by means of the ballistic galvanometer and these three exploring coils how much magnetism gets into the armature at different distances, and are able thus to determine the leakage and compare these amounts with the calculations made, and with the attractions at different distances. The amount of magnetism that gets into the armature does not go by a law of inverse squares, I can assure you, but by quite other laws. It goes by laws which can only be expressed as particular cases of the law of the magnetic circuit. The most important element of the calculations, indeed, in many cases is the amount of percentage of leakage that must be allowed for. Of the magnitude of this matter you will get a very good idea by the result of these experiments following.

The iron core is 13 millimeters in diameter, and the coil consists of 178 turns. The first swing of the galvanometer when the current was suddenly turned on or off measures the number of magnetic lines thereby sent through, or withdrawn from, the exploring coil that is at the time joined to the galvanometer. The currents used varied from 0·7 of an ampere to 5·7 amperes. Six sets of experiments were made, with the armature at different distances. The numerical results are given below:

I.—WITH WEAK CURRENT (0·7 AMPERES).

		A	B	C
In contact		12,506	13,870	14,190
Armature distance.	1 mm	1,558	2,163	3,786
	2 mm	1,149	1,487	2,839
	5 mm	1,014	1,081	2,018
	10 mm	676	1,014	1,600
Removed		—	675	1,352

II.—STRONGER CURRENT (1·7 AMPERES).

		A	B	C
In contact		18,240	19,590	20,283
Armature distance.	1 mm	2,570	3,381	5,408
	2 mm	2,366	2,839	5,073
	5 mm	1,332	2,199	5,049
	10 mm	811	1,352	3,381
Removed		—	1,308	3,041

III.—STILL STRONGER CURRENT (3·7 AMPERES).

		A	B	C
In contact		20,940	22,280	22,960
Armature distance.	1 mm	5,610	7,568	11,831
	2 mm	4,597	6,722	9,802
	5 mm	2,569	3,245	7,436
	10 mm	1,149	2,704	7,098
Removed		—	2,316	6,427

IV.—STRONGEST CURRENT (5·7 AMPERES).

		A	B	C
In contact		21,980	23,660	24,040
Armature distance.	1 mm	8,110	10,810	17,220
	2 mm	5,611	8,464	13,886
	5 mm	4,056	5,273	12,687
	10 mm	2,029	4,057	10,148
Removed		—	3,581	9,795

These numbers may be looked upon as a kind of numerical statement of the facts roughly depicted in Figs. 31 to 34. The numbers themselves, so far as they relate to the measurements made (1) in contact, (2) with gaps of one millimeter breadth, are plotted out on Fig. 44; there being three curves, A, B, and C, for the measurements made when the armature was in contact, and three others, A_1, B_1, C_1, made at the one millimeter distance. A dotted line gives the plotting of the numbers for the coil C, with different currents, when the armature was removed.

On examining the numbers in detail we observe that the largest number of magnetic lines forced round the bend of the iron core, through the coil C, was 24,040 (the cross section being a little over 1 square centimeter), which was when the armature was in contact. When the armature was away, the same magnetizing power only evoked 9,795 lines. Further, of those 24,040, 23,660 (or 98½ per cent.) came up through the polar surfaces of contact, and of those again 21,980 (or 92½ per cent. of the whole number) passed through the armature. There was leakage, then, even when the armature was in contact, but it amounted to only 7½ per cent. Now, when the armature was moved but 1 millimeter (*i. e.*, $\frac{1}{25}$ inch) away, the presence of the air gaps had this great effect, that the total magnetic flux was at once choked down from 24,040 to 17,230. Of that number only 10,810 (or 61 per cent.) reach the polar surfaces, and only 8,110 (or 47 per cent. of the total number) succeeded in going through the armature. The leakage in this case was 53 per cent. With a 2 millimeter gap, the leakage was 65 per cent. when the strongest current was used. It was 68 per cent. with a 5 millimeter gap, and 80 per cent. with a 10 millimeter gap. It will further be noticed that while a current of 0·7 ampere sufficed to send 12,506 lines through the armature when it was in contact, a current eight times as strong could only succeed in sending

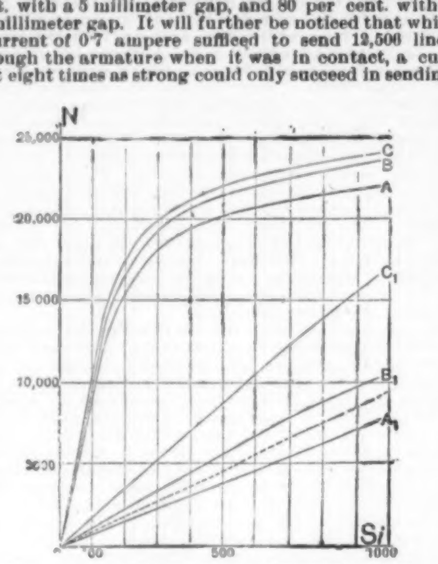


FIG. 44.—CURVES OF MAGNETIZATION PLOTTED FROM PRECEDING.

8,110 lines when the armature was distant by a single millimeter.

Such an enormous diminution in the magnetic flux through the armature, consequent upon the increased reluctance and increased leakage occasioned by the presence of the air gaps, proves how great is the reluctance offered by air, and how essential it is to have some practical rules for calculating reluctances and estimating leakages to guide us in designing electromagnets to do any given duty.

(*To be continued.*)

AN ELECTRIC HEADLIGHT.

THERE are two distinct views of the function of a headlight. It may be looked upon, as it is to a very large extent abroad, as simply a signal light for the benefit of track and station men, or may be regarded as an illuminator intended to show possible obstacles on the track at a sufficient distance to enable the stopping of the train without the disastrous results of a collision. There is a well known popular theory that the headlight is not of much use to an engineer anyhow, and if we consider the ordinary forms of reflector lamp now in use, it is not at all improbable that such a theory of inefficiency is correct. A headlight which merely shows the track a few yards in front of the engine can do little toward averting a collision, provided the train is running anywhere near the usual speed. It is to the use of electricity that we must look for a light of sufficient power to show plainly the condition of the track for a long distance in front of the train. An apparatus has been in practical use on several roads and the results of experiments have been most gratifying. It is the invention of G. C. Pyle, of Indianapolis.

The little dynamo and engine are between the smokestack and the headlight operated by them. The engine is one of the multiple cylinder class, and is very small, perhaps the smallest engine complete and perfect in all its parts that has ever been put to practical use. Its full output is only about three horse power, and a three quarter inch pipe is ample to supply the steam which is taken from the back end of the boiler, so that the throttle is always within easy reach of the engineer.

The minute engine is connected directly to the armature spindle of a dimutive dynamo in the most compact form. Designed to supply only a single arc lamp, no special regulation is necessary, and the only care required is to keep the bearings oiled and the brushes, which need never be shifted, trimmed and smooth. The total weight of the engine and dynamo together is but 650 pounds, and the combination occupies a space twenty-eight inches long, fifteen inches wide, and seventeen inches high. The normal speed in 425 turns per minute.

In fitting the apparatus to a locomotive the headlight is usually moved forward a little to secure the necessary space between it and the stack for the location of the machinery. The entire plant is under complete control from the cab, as a single turn of the valve in a supply pipe will start up the light or extinguish it when running. The lamp is of the rack feed style. The carbons run in guides, thus steadying them at a point quite close to the arc, so that any vibration of the engine will not jar the carbons sufficiently to break them or to destroy the continuity or uniformity of the arc. The lower electrode, instead of being carbon, is a copper rod. The light given is nominally 2,000 c. p., and proves amply sufficient for railway usage, although the power could be largely enhanced if it were desirable. Electric lights are now used on the Vandalia; Cincinnati, Hamilton, and Dayton; Indianapolis, Decatur and Western; Wabash; Michigan Central; Columbus, Hocking Valley and Toledo; Louisville, New Albany and Chicago; and Milwaukee, Lake Shore and Western roads.

A dozen or fifteen telegraph poles in front of the engine can be distinguished readily, even when the weather is not altogether good, and on an exceptionally clear night as many as thirty-three poles have been counted from the cab of the engine illuminated by the powerful light. Poles are about twenty-nine or thirty to the mile. Even in bad weather, when the illuminating power of the lamp could not fairly be expected to be anywhere near its maximum, the view for 1,000 or 1,200 feet ahead of the engine is substantially as good as in daylight. Small obstructions on the track could readily be made out at that distance even by an inexperienced eye, while a great or large object would be easily visible nearly half a mile. Sitting in the cab of an engine provided with this headlight is a decidedly new sensation. Small objects like mile posts can be readily seen at a distance of a mile in good weather, and even the joints in the rails can be seen 700 feet ahead. The only objection which might be raised to the use of an apparatus of this kind is that which has been advanced against the electric light before by pilots. Running toward a powerful light of this kind on a double track, it might sometimes be a little difficult to distinguish landmarks by reason of the glare. But even the ordinary headlight is somewhat objectionable in this respect, and it is quite certain that additional range gained by the use of electricity will more than compensate for any additional glare. The case is much more favorable, at least, than that met with by pilots, because, although there is an intensely brilliant light from the approaching engine, yet the driver's own machine is casting forward a beam of equal intensity, making the track ahead as bright as day for a long distance.—*Electrical World.*

TANNING BY ELECTRICITY.

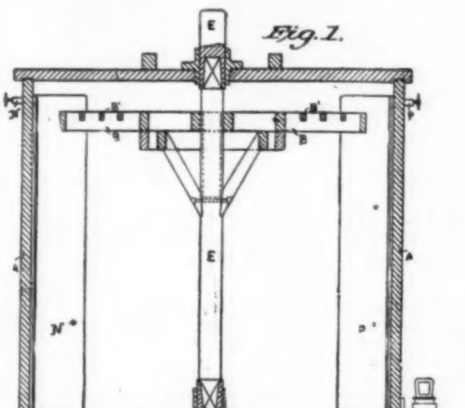
L. A. GROTH, of London, is the author of this plan, which he describes as follows:

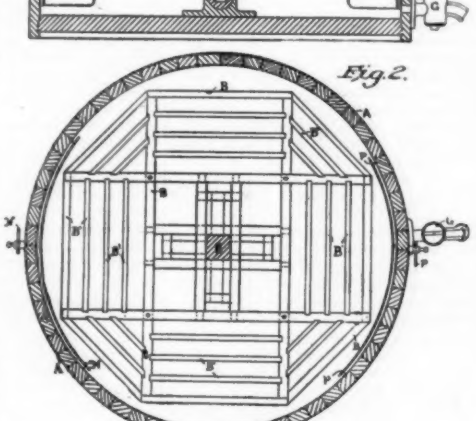
Figs. 1 and 2 are respectively a vertical section and a plan.

A is a tank or other suitable vessel containing the tanning solution.

B is a frame work connected to and revolving with a vertical central shaft E and provided with bars B', furnished with pegs, pins, or hooks, to which the hides or skins are suspended so as to hang down in the tanning liquid; or, if preferred, a second frame work, similar to B B', may be applied at the lower end of the shaft E, the lower ends of the skins being attached to such frame work, so as to hold the said skins stretched between the two frames.

N and P are electrodes connected with a dynamo or other suitable source of electricity for the purpose of





passing a current of electricity through the liquid in the tank, A, while the frame work, B B', rotates with the hides or skins thereon.

Instead of a special tank, A, as above described, an ordinary tan pit may be used to receive the revolving framing, and it will be understood that the necessary rotary or other motion may be imparted to such framing by worm gearing, toothed wheel work, or other suitable gearing, or direct by belting or otherwise, as may be most convenient.

It is obvious that the framing may be made to rotate continuously in one direction or alternately in opposite directions; or the frames or bars on which the hides or skins are hung may be caused to reciprocate in a rectilinear or other direction, so as to move the hides or skins to and fro in the tanning liquid while the electric current is acting thereon.

The apparatus is employed as follows: A number of hides or skins having been placed on the frame work, B B', as above described, tanning liquor is admitted to the tank, A, until the hides or skins are immersed in such liquor. The framing, B B', and consequently the hides or skins, is set in motion in the tanning liquid and the electrodes, N P, are connected to the source of electricity, so that a current of electricity is passed through the liquid. The motion of the framing and of the hides or skins is continued for about four days, more or less, according to circumstances, the current of electricity being maintained during that time or during a part thereof only according to circumstances and as may be necessary for the materials under treatment. At the end of that period the tanning of the hides or skins will be completed. The motion of the apparatus is then arrested, the current of electricity stopped, if it has not been previously stopped, the tanning liquor drawn off from the tank, A, by the tap, G, or otherwise, and the tanned hides or skins removed. Fresh hides or skins are then put on the fram-

ing, B B', and the cycle of operations repeated, and so on continuously.

With the apparatus above described I am enabled to effect the tanning of hides or skins by the aid of electricity much more rapidly than can be effected by the ordinary process of tanning and without the danger of explosion to which closed revolving drums are, as above mentioned, liable, while the apparatus containing or carrying the hides or skins, not requiring to be water tight as it revolves or otherwise moves in the tanning liquid, is much easier and more cheaply constructed, does not require to be so strong and heavy, requires less power to operate it, and is simpler to manipulate than the aforesaid closed drum arrangement.

The framing and bars are preferably made of timber; but other suitable material which will not act injuriously on the tanning materials may be employed.

In the action of the electric current different results take place at the positive and negative electrodes, respectively, and it will be seen that by moving the hides relatively to the said electrodes according to my invention and as herein specified, the whole of the surfaces of the same are subjected to a uniform as distinguished from a partial or unequal electrolytic action.

ORGAN BLOWING BY ELECTRIC MOTORS.

AMONG the industrial applications of the electric motor, there is none more interesting than that of blowing church organs. This field of electrical application has been exploited by one company only, the C. & C. Motor Company, of New York, and it is entirely due to the ingenuity of Mr. W. S. Chester, of that company, that this new field has been so successfully occupied. In addition to being an electrician, Mr. Chester is also an organist, occupying that position in St. George's Church, New York, and about a year ago it occurred to him that the electric motor could do the work of filling the great bellows of the many organs in our churches much more efficiently than men, and much more economically than water or gas motors.

Very few of the regular attendants of churches appreciate the anxieties of the organist, who is dependent entirely upon human power for the wind to give voice to his efforts, nor the straits to which the authorities are put to obtain the means to blow the organs, nor how often the service is in danger of interruption from the unreliability of the methods employed. Yet the music is entirely dependent upon the power applied to the bellows handle, and when this power can be depended upon, the organist is relieved from at least one of his already long list of cares.

The great majority of organs are pumped by hand, but in this age of progress, when the most approved means of mechanical power are taking the place of the old methods, some substitute has been long eagerly sought for, and water, gas, hot air, and steam have each, in one form or another, been utilized for this purpose.

With the introduction of electric lighting and the gradual extension of the electric light wires, the use of the electric motor for this purpose is now becoming possible. The erection of stations for supplying current in the upper portion of New York City has already enabled many of the churches within reach of their wires to avail themselves of the opportunity to apply this power to their organs. The ease with which the electric motor can be installed and connected to the street wires, the smoothness of its operations without heat, noise or odor of any kind, requiring scarcely any attention, the organist merely starting and stopping it by a switch within reach of his hand, and the very moderate outlay required for installing and operating it, proved at once its great superiority over all the other methods that have been employed for this purpose.

If an organ is built for power, its attachment is the work of a moment. If built to be pumped by hand, it can easily be transformed into one ready for power, although this should be done with great care. Regulation may be effected by varying the speed of the motor by the movement of the bellows, or by using a constant speed motor and employing a mechanical movement to connect or disconnect the power, by shifting a belt which is acted upon by the rise and fall of the bellows.

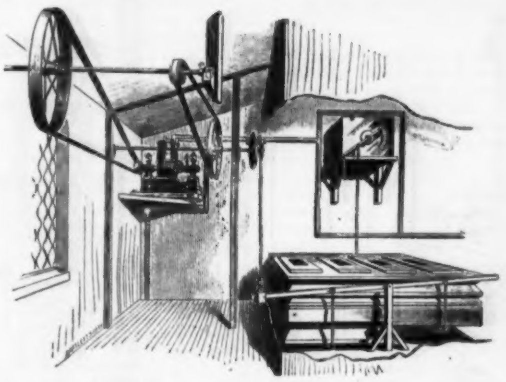
St. Paul's Chapel, situated on the corner of Fulton Street and Broadway, in the lower part of the city, within reach of the wires from the old Edison station, was the first church that offered an opportunity for applying the new method to its organ. The authorities were at first skeptical as to the success of the power, but soon became convinced that it was what they had long been looking for. This church belongs to Trinity Parish, and the Trinity Corporation soon showed their appreciation of the excellent work that this motor was doing by directing that the organs in old Trinity Church be similarly fitted up.

Probably no problem in organ blowing was as difficult to solve as that of efficiently blowing the large organ in old Trinity. The scale of the pipes is larger than any other in this country, and many stops have from time to time been added to it without at the same time enlarging the bellows. The bellows, as originally designed, were too small for the work which they had to do, and the needed addition to them was never made. To answer satisfactorily, therefore, this great demand was indeed a problem, but the electric motor as installed satisfies all the requirements put upon it, and it would be difficult to suggest the slightest improvement that could be made to the plant.

The organ is located virtually in the main body of the church, the large ornamented pipes that form its front merely shutting out the view of the more unsightly portion behind, and any noise made there is instantly caught by the arch overhead and made to reverberate through the building. Even here, however, the electric motor performs its work so noiselessly that nowhere in the church is the slightest sound from it perceptible, a result which it is safe to assume that electricity alone could attain. The illustration shows clearly how this motor is attached to the organ. The belt from the motor runs to a large pulley on the countershaft, on which are two driving pulleys leading to pulleys on the driving shaft. Each bellows controls a part of the organ. They are both automatic in their working, and when full are made to cut off. When, however, one part is used beyond its capacity, an automatic arrangement opens a connection between both bellows, causing the secondary bellows to aid the primary, thus insuring an abundance of wind without straining either bellows. The motor is started from the keyboard, and since full power can be obtained at any instant, a power of tone never before heard surprises even those who are most familiar with this grand old organ.

The chancel organ is clearly shown in the illustration, and hardly requires further explanation.

A similar arrangement is found in the case of the organs of St. Patrick's Cathedral. Here the small organ is so placed that the motor has to stand in the very chancel, but it is impossible to perceive the slightest sound from it. The speed of the motor in this case is regulated by a resistance box. The lever on the box is connected to the bellows, and their movement causes more or less resistance to be thrown into the motor, thus automatically regulating its speed to conform with the needs of the organ.



CHANCEL ORGAN IN TRINITY CHURCH.

Each organ must have its own resistance box, and it is only by knowing the size of the bellows, *weight* to be lifted and the *number* of strokes, that the dimensions of the box can be determined. With the proper resistance in the box the bellows will automatically control the speed of the motor with absolute exactness.

Another feature is the method of winding the motor so as to admit of its reaching its maximum speed in much quicker time than the average engine, thus enabling the organist while playing the lightest combinations to suddenly draw on full organ without exhausting the wind before the motor has again attained its full speed and begun filling the bellows.

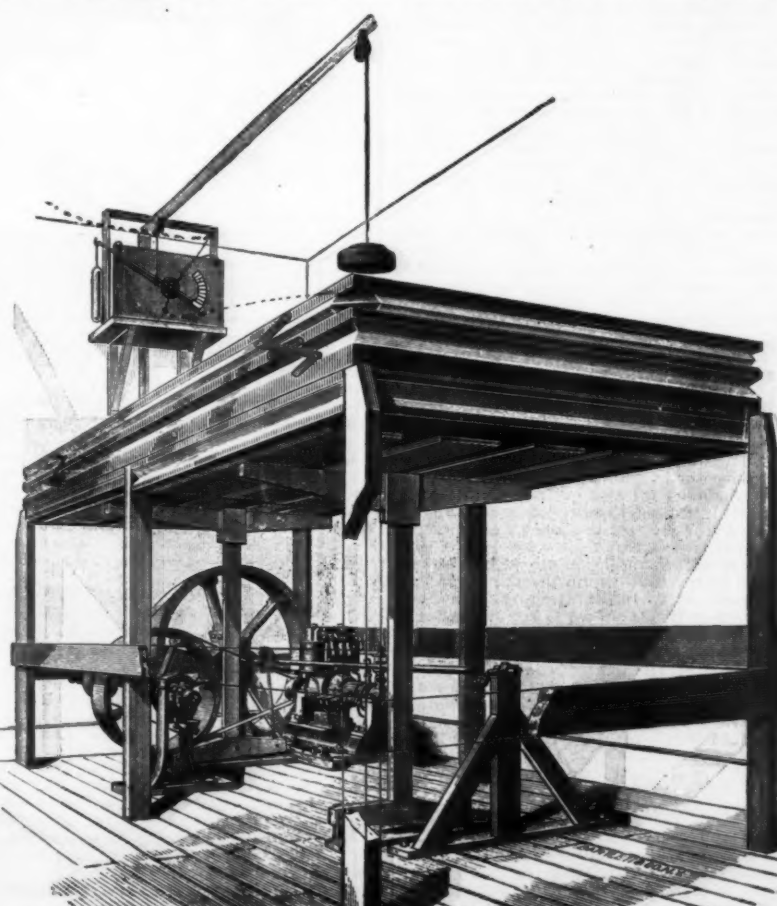
Perhaps the most compact plant yet installed is that in the Church of the Holy Communion. The pulleys, countershaft, driving shaft, and motor are all placed under the bellows, and the whole arrangement occupies a space about five feet by two. In our cut we have endeavored to show how close the various parts may be crowded together.

The installation at the Collegiate Church, at Twenty-ninth Street and Fifth Avenue, very nearly solves the problem of a compound organ. This organ has two bellows; one supplies the entire organ with the exception of one register, which is supplied by a high pressure bellows. The arrangement is to throw this bellows into automatic action when the stop is drawn, thus making the supply of wind available. When the stop is put in, the automatic arrangement is checked and the supply is cut off.

We have here endeavored to present a brief outline of some of the difficulties that had to be contended with in entering on this new field for the application of electric power. Each case presents its peculiar conditions which have to be met in a great variety of ways, but in no single instance has the electric motor failed to fill all the requirements. In each case it has been applied to an organ already in operation, and has thus successfully contended against and displaced nearly every other form of power known to organ blowing.—*Electric Power.*

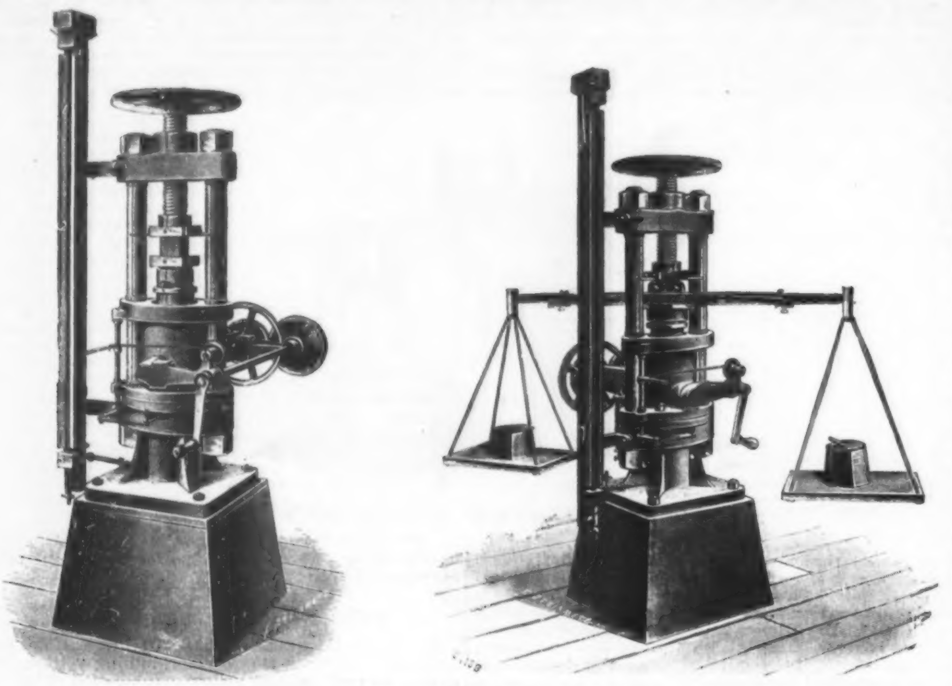
NEW MILLING YELLOW DYE.

MESSRS. L. CASSELLA & Co., Frankfurt a. Main, have recently introduced a new color, milling yellow. For dyeing on wool, milling yellow may be used either as a self-color or in mixtures. Used as a self-color, it produces a pure, deep, yellow, which is equal to fustic or flavin as regards fastness to milling, and with regard to fastness to light, it surpasses both by far. At the recent exhibition of army requirements in Cologne, there was exhibited some cloth for army purposes, dyed with milling yellow, side by side with cloth dyed with flavin, as prescribed hitherto by the military authorities. The flavin faded, showing a dirty yellow color, after an exposure to light for a few weeks; milling yellow, on the contrary, retained all its brightness, even after months. The dye penetrates heavy fabrics, and dyes quite evenly, if a little is taken. It can also be used in mixtures, and for shading other colors fast to milling; it can be dyed like alizarine colors on a chrome mordant, as well as in an acid bath, as usual. These remarks apply to wool and silk alike. Milling yellow is fairly fast to acids, and stands sulphurous acid (stoving) well. If used as a self-color, it may be dyed on wool with acetic acid, Glauber's salt, sulphuric acid, or bisulphite of soda. It possesses the property of going on to the fiber slowly or quickly according to the quantity of acid used. It will dye very quickly with 10 per cent. bisulphite of soda, but if the goods require to be treated carefully, it answers better to start with 2 to 8 per cent., turning frequently and heat-



MOTOR IN THE CHURCH OF THE HOLY COMMUNION.

ing slowly, then to add another 2 to 3 per cent. bisulphite of soda, in case the bath is not sufficiently exhausted in half an hour. In cloth dyeing, the best results are obtained by first cooling for one hour, with 10 per cent. acetic acid, and then adding the coloring matter. Silk is dyed with acetic acid or, as more usual, in boiled off liquor acidulated with acetic acid. Its extreme fastness renders milling yellow, also, of great importance for printing woolen fabrics and slubbing, both as a self-color and in mixtures. The dyestuff can easily be fixed, so as to be a fast color, without the use of chloride. The following proportions give good results: 20 lb. thickening; 2 lb. milling yellow O; 8 lb. water; mix well, heat, and after cooling, add 4 lb. acetic acid.—*Jour. Fabrics.*



IMPROVED CEMENT TESTER.

IMPROVED CEMENT TESTER.

WE illustrate a testing machine manufactured by J. Amsler-Laffon & Son, engineers, of Schaffhausen, Switzerland, and intended for crushing experiments on blocks of cement or similar material. The machine is an hydraulic one, but the load is measured, not by a weight as in the ordinary hydraulic testing machines, but by a mercury column. It is capable of exerting a pressure of 20 tons, which is sufficient for cement cubes of 2¾ in. edge. Under the load the pressure of the fluid in the main cylinder of the machine is 120 atmospheres, corresponding to a mercury column 300 ft. high. As anything like this height is totally impracticable, the pressure to be measured by the column is reduced in the following manner: Beneath the main or loaded cylinder is a second or measuring cylinder, forming the reservoir of the mercury gauge. In this cylinder is a piston very accurately fitted, which rests on a layer of oil, and this in turn floats on the mercury of the reservoir. The pressure on the load cylinder is transferred to the piston of the measuring cylinder by a small piston let into the bottom of the former, and fixed on the same rod as the large piston of measuring cylinder. By this means the height of the gauge is reduced to the very reasonable limit of 4 ft. 11 in.

The load is put on the specimen by forcing into the load cylinder, by a screw gear, a small ram. The screw is actuated by a train of wheels, driven by the handle, as shown in our engravings. There are two pinions on the driving shaft, one of which gives a slow and the other a quick motion to the ram; the former is used when the load is being put on the specimen, and the latter coming automatically into play when the motion of the handle is reversed for withdrawing the ram. To insure equality of pressure on the specimen the lower crushing plates rest on a spherical seat. There is no water packing to the various pistons, but leakage is prevented by good workmanship, and the use of a somewhat viscous oil, instead of water, inside the cylinders. To eliminate the last traces of friction, where this would have the most influence on the accuracy of the results obtained, the two lower pistons are kept in a constant state of vibration during the experiment by a light lever which is actuated by a system of links connected with a crank on the pinion, shown just above the handle in our engravings. A form of balance has been specially designed for calibrating the machine, and the application of this is shown in the engravings, the pressure between the crushing plates of the machine being measured by the loads on the scale pan and the indications of the mercury gauge checked. As the mercury falls when the block crushes, the actual measurement of the crushing pressure is taken from an iron float which rises with the mercury, but is left behind when the fluid falls.—*Engineering.*

A NEW FLEXIBLE TUBE.

By THOMAS R. ALMOND, of New York, N. Y.

THE following is an abstract from a paper read before the American Society of Mechanical Engineers:

In the drawings, Fig. 1 represents a longitudinal central section of a flexible tube made according to this invention, showing it on a mandrel. Fig. 2 is a similar view on a larger scale of said tube partly in face view. Figs. 3, 4, and 5 are sectional diagrams showing different forms of parts.

A flexible tube composed mainly of two coils of wire, one of which is placed around a mandrel, the other being forced into the interstices between the convolutions of the first coil, so as finally to enter between the convolutions of the first coil and reach contact with the mandrel. In this arrangement I use an outer coil, A, of triangular cross-section, which outer coil I force between the convolutions of the inner coil, D, while the same bears on the mandrel, B, so that thus the tapering or wedgelike edges of the outer coil, A, will serve to at all times keep the convolutions of the inner coil, D, under tension, seeking to spread them apart, where otherwise they would tend to approach one another. By imparting to the outer coil, A, this triangular form I obtain the additional advantage of securing a larger contact face than is obtained by the cylindrical wire and of insuring a more perfect closure while the flexible pipe is bent.

The triangle of the outer coil, A, may be equilateral and straight sided, as in Fig. 4, but I much prefer to make the contact faces, *a a*, which butt against the coil, D, of concave form, the curvature being on a circle of which the center lies in the axis of the mandrel, B. This curved or concave triangle in contact with the inner coil, D, is shown in Fig. 3 and has the advantage of giving a still greater contact face and of producing a tighter joint when the tube is bent, but Fig. 5 shows a still better form in that the inner coil, D, has contact faces, *b*, on the same curve as the contact faces *a*, of the concave triangles, A.

One way of making this improved tube is to first place around a mandrel, B, the coil, D, and then to force between the convolutions of that coil the triangular coil, A, so that the wedge-like convolutions of this coil, A, will enter between the convolutions of the coil, D, tending to spread them apart, and insuring therefore a tight joint, which will be maintained tight even when the tube is bent to a reasonable degree. In using the tube the mandrel is of course removed.

It seemed to me at first rather a wild kind of an idea to make a metallic tube which would be quite flexible, and which could be used for conveying illuminating gas. I have, however, after many experiments succeeded not only in making a flexible tube for such purposes, but also one which will convey gases, steam or liquids under considerable pressure. This tube has sufficient flexibility for all practical purposes, with the additional advantages of great strength and durability.

When a tube is formed by coiling a wire around a mandrel, the convolutions may be made to press upon each other with considerable force, and the joint formed at the point of contact of the individual convolutions will be tight in proportion to the amount of pressure exerted. If such a tube be bent, the joints will be broken all around the coils except at one point, and therefore, when bent, it is useless for conveying liquids or gases.

Wishing to utilize the peculiar flexibility of spiral spring tubing for the conveyance of gases in cases where a flexible tube is required, I conceived the idea of interposing a triangular shaped wire between the coils of a round wire, as shown. When a tube so constructed is bent, the convolutions of the triangular coil adjust themselves to the spaces between the round coils. The triangular wire is pressed between the coils of the round wire, during the process of constructing the tube, with sufficient force to spread them apart, so that the contact surfaces are at all times under pressure. The triangular wire serves two purposes: one is to spread the coils apart, so that the pressure will be exerted on the contact surfaces; the other, to fill the irregularly shaped spaces between the coils of round

Fig. 1.

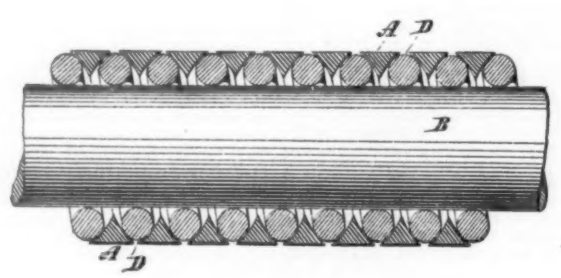


Fig. 2.

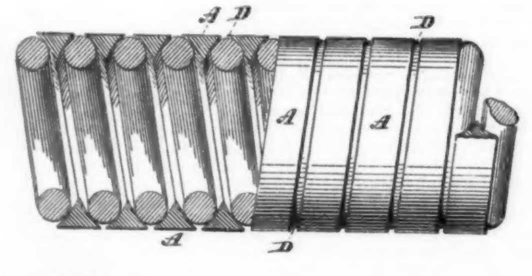


Fig. 3

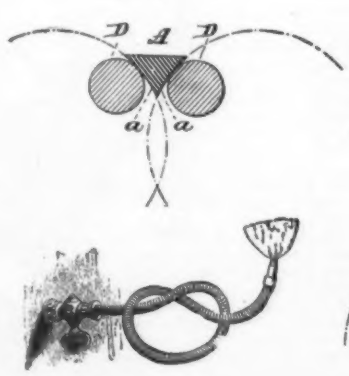


Fig. 4.

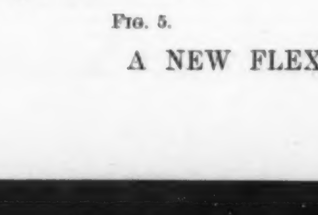


FIG. 5.

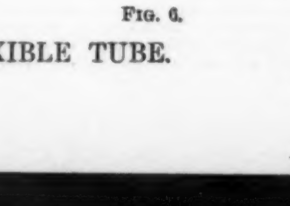


FIG. 6.

A NEW FLEXIBLE TUBE.

wire, adjusting itself to the changing form of the spaces due to any given flexion. This pressure brings into play the element of friction to such an extent as partly to destroy the flexibility of the tube, which, when bent, will retain the form given to it. This was an unlooked for and unexpected quality.

The degree of flexibility depends upon the amount of tension put upon the inner coil, or the extent to which the convolutions are forced apart.

I have produced a perfectly tight tube with two coils of round wire, in which the outer coil is wound sufficiently tight between the convolutions of the inner coil to spread them apart for the purpose of getting pressure on the joints, substantially the same as with the triangular wire. This makes a very strong tube, but is too bulky for many purposes. Two half round wires, or even less than half round, may be used; or the inner wire may be round, and the outer half round, or much less than half round. The tube will then be less bulky, and, supposing the outer wire to be considerably less than half round, the convexity of its surface may be such as to give results similar to the obtuse triangular wire. I have made several tubes in which the contact surfaces of the coils are made to coincide with a circle whose center is the axis of the tube. The joints so formed are practically a series of ball and socket joints; such a tube has smoother outer and inner surfaces than those previously described. A serious objection to such a tube is that the wire changes its shape during the process of coiling, so that the joint surfaces will not make sufficiently complete contact, whereas the forms of wire previously mentioned are of simple construction, and the slight change of form which occurs during the process of coiling will not affect the result. The extent to which this tubing may be bent without leakage is considerable; a piece of one-quarter inch bore, tied as shown, has been subjected to a steam pressure of 75 lb. without leakage; the smallest curves of the bent portion corresponded in this case to a circle 2 in. in diameter. I have not yet made any tube larger than 5-16 in. bore, but think it possible to make them as large as 1 in. bore, and strong enough to stand any ordinary steam pressure.

ROMAN REMAINS AT SILCHESTER, ENGLAND.

I SEE a vast area, flat, laid out in fields; an arable land surrounded by a wall eleven to seventeen feet high. A broad modern road runs through it. A few low mounds rise here and there. You might drive through the road, hardly noticing the wall as you enter this area, or as you go out of it. You might look across the flat land to right and left and never dream that, a foot or two below the surface, there lie the foundations and the floors, the tesselated pavements and the hypocausts of a great city, of which not a single tradition or memory survives. This is the ancient Calleva, once capital of the tribe or nation of the Atrebates. The meager chronicle which contains the very few facts on record of the Anglo-Saxon Conquest gives no account of its conquest. Perhaps it was taken by Ælla after the destruction of Anderida on his march to Bath. Perhaps, like that place, it was sacked and destroyed, with a massacre of the people. The finding of burned wood clearly points to such a calamity. Perhaps it was only partly destroyed, some of the people being spared. These gradually died out or went away, because, as in so many other places, the old order being subverted, there was no longer any need of the town, or any means of subsistence for the people. There are many other instances of the "Waste Chester"—the deserted town. Notably Rutupiæ, now Richborough, has never been built upon or inhabited since the Romano-British occupation ceased. Porchester is another case; here a church was built in one corner, and a Norman castle in another, but the great area within the walls has never been built upon. Pevensey is another case. Here again a Norman castle stands in one corner, but the area of the ancient town consists of unturned and untrodden turf. In all cases it is remarkable as illustrating the thorough nature of the conquest that not a single legend survives or a single building stands above ground—except the crumbling walls—of the Roman period. At Silchester as at Colchester, York, Verulam, London, and everywhere else, not a tradition or legend remains of the city before the coming of the English.

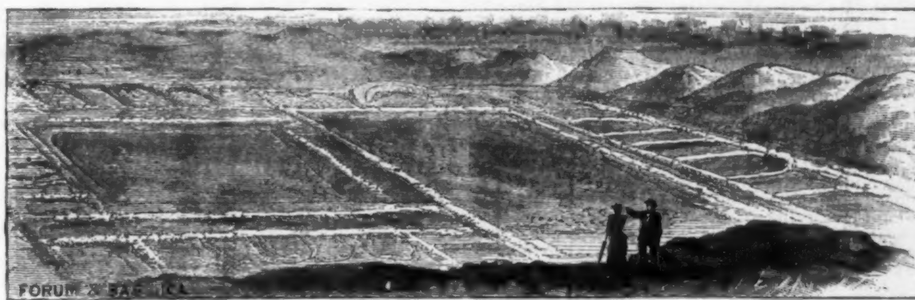
Besides the discovery of foundations, many things are picked up among the ruins. These are all preserved in a small museum. The cases present the usual objects familiar in all museums of Roman antiquities. There are capitals, pottery of various kinds, implements and tools, weapons, toys, "safety" pins, locks, etc. Here is the foot of a statue, there is a little broken glass; and there are coins of a great many Roman emperors, ranging from those of Claudius to those of the last emperors before the legions were recalled.

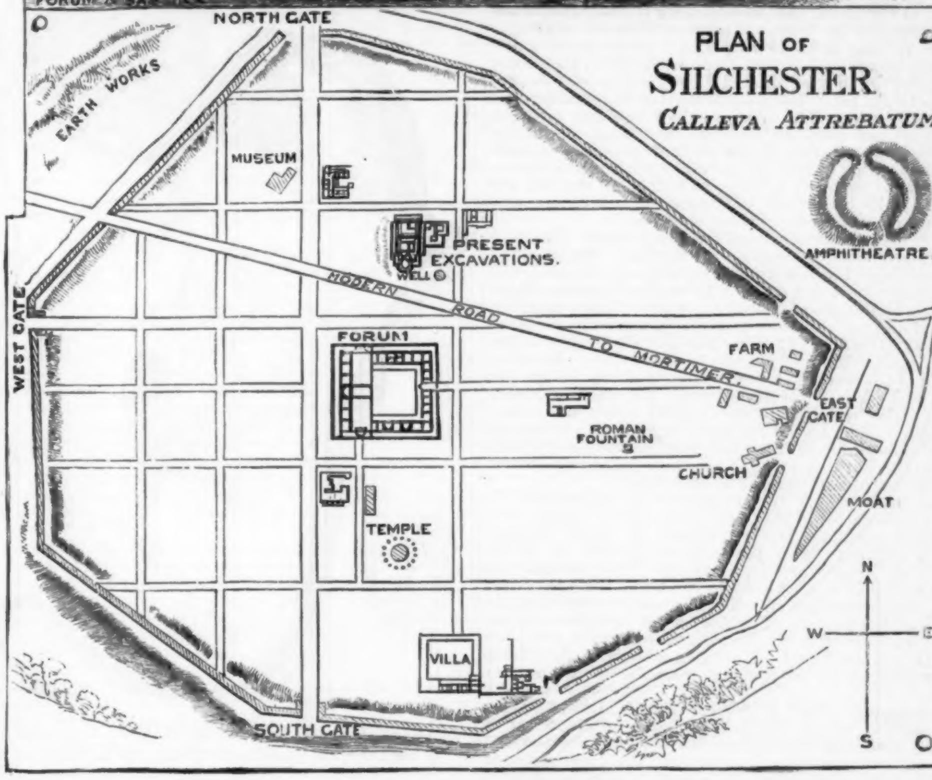
The most interesting part of the place is the Forum, which may be completely studied. This is the official center of the town. Here is the great Basilica, a hall 280 feet long—40 feet longer than Westminster Hall. It has an apse at one end, and an aisle is clearly marked by the site of pillars. On the west side of it are three great chambers for legal and civic business; on the east side is the Forum with its public office; on the south and on the north, its row of shops. Here the whole business of the city was carried on; here the people thronged—strolling about the ambulatory in fine weather, and in cold weather flocking into the Basilica. The town, though now so deserted, was connected by roads with London, Winchester, Old Sarum, Bath, and Cirencester; and it preserved some dignity as the former capital of the Atrebates. One cannot believe that the Roman conquest quite obliterated the memory of the old "nations," the tribes of Britain, each of which had its chief town—some of them large and important places. Here and there, as at Sorbiodunum—Old Sarum—one was garrisoned by the Romans. Probably there was never any garrison at Calleva, and the security of their life, the perfect safety of the place, so far inland, so well protected, with its fine air, made it a favorite place with the Romano-Britons. Certainly, this safety caused the young men to grow up unused to arms and unfit to carry on war when their turn came.

A perfect ground plan of a villa has been laid bare. It shows with what comfort and luxury the better class lived. The tenant of this house, which was probably of one story only, had a cloister built round three sides of a quadrangle, the fourth side remaining open; it inclosed a small garden, but a larger garden lay outside. Behind the cloister he had large rooms for summer and for winter use. Those for the latter were warmed by hot-air pipes connected with great underground stoves, which can be seen. Behind these chambers was another cloister, and at the back were what we call the offices, kitchen, pantry, and larder, with, I suppose, sleeping rooms for some of the household.

The large area occupied by this one villa would seem to show that the population could never have been very great. But then, we know so little; this may have been an exceptionally large house—nay, it must have been. Moreover, we know not how many slaves were attached to this household. Nor do we know, until other *insulæ* have been examined, of what kind were the houses of the lower sort. Not the least valuable result of a complete examination will be the light thrown on the population of a Roman town and its distribution. The conclusions formed at Silchester will be usefully applied to London.

Outside, the great wall stretches round the town. It is not quadrangular, like Porchester, nor oval, like Sarum. It is an irregular polygon, following, most likely, the line of the older earthworks of the Atrebates. Its length is 2,670 yards, and it incloses an area of 100 acres. These figures mean nothing: say, then, that Silchester is exactly the same size as the City of London. The wall is built without tiles. There is a layer of bonding stones, then comes mortar, then flints and so on. When the builders grew tired of flat bonding stones, they adopted a herring-bone pattern. The gates are recessed for greater protection, so that an enemy would be exposed to weapons in flank. The wall is, indeed, a most beautiful monument. It is overhung with trees, and overgrown with creeping plants—*Walter Besant in Illustrated London News.*





ROMAN REMAINS AT SILCHESTER, ENGLAND.

THE CULTURE AND PREPARATION OF FLAX.

THE no doubt well meant efforts of Congress to encourage the growth and manufacture of flax in the United States will necessarily give rise to considerable inquiry among farmers as to the possibility of naturalizing this industry here; and a fair statement of the case, based upon accurate knowledge of the character of the plant and its fiber, and the process of preparing it for use, will be of interest and value to your readers, and may prevent loss and disappointment to many who might, as I have done several times during the past thirty years, make an effort to grow the plant for profit.

My first effort was made in Michigan thirty years ago, after returning from a lengthened visit to Europe, during which I spent a few weeks in the north of Ireland, in the center of the flax-growing district, and later in Pennsylvania. In Ireland I witnessed the latter stages of the culture of this crop, and the preparation of the fiber for sale to the linen factories, several of which I visited. On my return I prepared a piece of land, and had it sown with flax by a man who came from this same district, and who seemed to be as sanguine as I was that we could grow flax in America. But every effort to grow fine fiber failed. A coarse fiber, fit for making grain bags, can be easily grown. The mode of culture common in the flax growing localities (that is for fiber for manufacturing) is as follows: A piece of rich sod land, low and moist, is plowed in the fall, and in the spring it is worked until the soil is as fine as a garden. Late in March or early in April the seed is sown at the rate of one and a half to two bushels per acre. It is usually sown in drills 8 to 10 inches apart, for facility in weeding, for one of the chief points of the culture is that the crop must be kept free from weeds by hand work, as with onions. As the crop is intended to be of fine or coarse fiber, the seed is more or less thickly sown; for the finest fiber as much as three bushels is sown per acre, and even more in some localities in Europe, where this crop is a staple, as in Belgium and parts of Germany and Russia.

When the fiber is the end in view, the crop is cut as soon as the blossom is perfect, and it is in view of this purpose that this description of the crop is given, for the culture of flax for seed is wholly different. And just here it might be stated that in ignorance of this necessity of the case much

misinformation has been spread in regard to the culture of flax in America. If the plant is left long on the ground, the fiber looses its strength and fineness, and becomes harsh, brittle and coarse. This is due to the natural change of the plant as the formation of the seed begins and its maturity approaches. The cellular tissue, which lies under the bark and over the woody core of the stem, changes into woody fiber to a large extent, and in ripening loses its peculiar fine fibrous structure, and nearly the whole of the soluble matter, which is intermingled with the fiber, and to which its peculiar structure, fineness, softness and strength are due. Hence it is futile to expect that fiber and seed can both be produced from the same crop. Some fiber of a coarse and very inferior character may be thus grown, but it is not available for any but the coarsest fabrics. And the frequent statements to the contrary of this are to be received with discredit, and as misleading, and opposed to the natural habit and character of the plant.

When the crop is ready for gathering, the plants are pulled up by the roots by hand; the soil is shaken from the roots, and the plants are laid evenly on the ground in small bunches, the various lengths being assorted as nearly as possible. This is necessary for the success of the next operation, which is the rotting, or "retting" of the stalks. The stalks are tied in small bundles with a band at each end, and with care to keep the stalks free from entanglement, which would interfere with further processes. Before the tying in bundles the stalks remain several days on the ground, exposed to the air and sun, but a common method is to range them in small stacks in this way. A row of the longest bundles is set on end, and shorter ones are arranged beside them, and so on until a stack is made. This is supported by stakes driven in the ground at the corners. Other bundles are then laid on the top sloping with it, and whole is covered with a sheet to shed the rain. This is done when the finest fiber is grown, to prevent discoloration. When the stalks are dry they undergo the process of retting. There is a difference of opinion among flax growers as to the propriety of this drying of the flax before the retting. Some begin this process while the flax is still green, believing the fiber is softer and more silky. Others keep the flax for some time, and under certain circumstances it is kept in the stack for as long as three or four years, in the belief that the ripening it undergoes tends to strengthen the fiber and increase its good quality.

The retting is done in the air or in water; air-retting, however, is apt to discolor the fiber, and is not practiced for the finer kinds. The purpose of this process is to get rid of the soluble matter which holds the fibers together. The fresh bark of the flax contains about 60 per cent. of fiber, 25 per cent. of matter soluble in water, and 15 per cent. of insoluble matter. But durng the fermentation of the retting, the insoluble matter becomes soluble, and thus in the end the fiber is quite freed from all entangling substances, and is combed out into long, silky threads.

Pure soft water is needed for this process. Lime or other hard water is injurious to the flax. The bundles are submerged in the water in a sloping direction, the roots downward and one bundle resting upon another; as the bundles are placed in the water planks weighted with stones or other weights are placed on them to prevent them floating. The flax quickly begins to ferment, and bubbles of gas rise to the surface. In about ten days the bark has been loosened from the woody core, and when it will slip off freely the process is complete. The bundles are then spread in a clean grassy meadow to dry, and when quite dry the flax is broken and then scutched. The first process consists of breaking up the bark and woody core into fragments, which are afterward combed out by scutching.

The best quality of flax grown in Ireland and in Belgium is dried in the field and stacked under cover until the spring, when it is retted in tanks through which running water passes, or is packed in crates which are submerged in a stream The bundles are then set up in small stooks in the field until quite dry, after which they are stored some months previously to the finishing process. The fiber when completed is put up in bunches with the threads all smoothly arranged and tied at each end. It is now seen why the plants are arranged as to their lengths in the pulling of them.

The average yield of dry raw flax is about 7,000 lb. per acre, of which 700 lb. is finished product. It is readily seen that were there no climatic obstacles in the way of this crop in America, the great amount of hand labor required to secure a salable product would be an insuperable obstacle. But this crop depends in a remarkable degree upon the climate for its successful culture. A prolonged dry season is fatal to the required quality of the fiber, checking its growth and making it uneven in quality and short in length. Much wet weather is equally injurious, as it weakens the fiber and makes it coarse. Any sudden change from a cool, moist, even temperature will damage the fiber and reduce its value. At five cents per pound for the finished product the yield would be $35 per acre, a value which would be absorbed by the crop long before the fiber could be brought into a marketable state, and although it might be possible to overcome the disadvantages of our summer heats and frequent droughts at the time when this plant needs cool, moist weather, the crop could not be grown with profit. But this is hardly possible.

The north of Ireland and the Baltic coasts of Europe have the right climate for flax, and yet its culture is steadily decreasing in Ireland and everywhere in Europe where improved agriculture is being introduced. Russia now produces the bulk of the world's product of flax fiber, and it is probable that it will continue to do so as long as that tyrannical government prevents the advancement of the people and keeps them in the deepest poverty. If there is any part of the United States where flax fiber can be grown to perfection it is in the highest plateaus of the Southern mountain region, where the temperature and climate are almost precisely like those of Northern Ireland. A rainfall of 65 to 100 inches per year pretty evenly distributed, and a low even temperature rarely rising above 70° until July, and then rarely above 80°, with rich soil and abundance of the purest water, offer all the requisite advantages for the growth of the best quality of flax. It is my purpose to try a crop next season. HENRY STEWART.

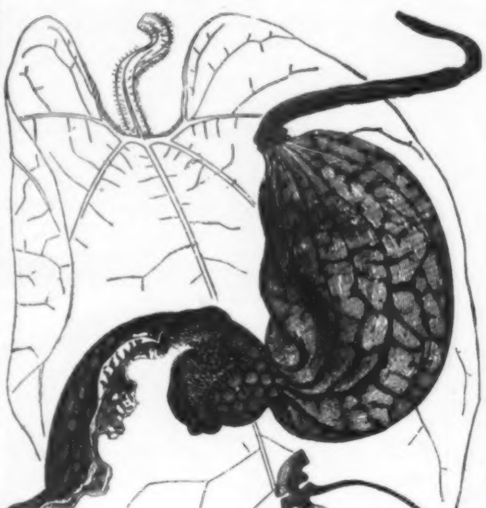
Macon County, N. C.

ARISTOLOCHIA LONGECAUDATA, *Masters.*

IT is only lately that we have had the opportunity of seeing a fresh specimen, cultivated by Mr. Todd, of North Cray, who brought the plant from Demerara. It is a handsome species of the unilabiate group, in which the solitary lip of the flower is prolonged into a very long tail. The leaves are leathery, five-nerved, cordate, entire, and densely setose on the under surface, glabrous above.

The flower, which is well shown in Mr. Worthington Smith's drawing, is cream colored, the net-like veins marked out in deep purple. The drawing sufficiently shows the botanical details, but we may call attention to the mouth and funnel shaped throat of the flower at the top of the distended portion of the tube, and which is of a deep velvety purple color, covered with coarse, white hairs or setæ, bulbous at the base, and with the points all directed downward toward the bottom of the flower, where is placed the column consisting of the stamens in union with the styles. A cut through the flower lengthwise shows these hairs, and also one of two dark cushion-like pads projecting from the upper part of the swollen tube. Obviously these arrangements have reference to the fertilization of the flower by means of insects, and Mr. Jenman, or other observers in Guiana, would do good service by observing what are the insects which effect the fertilization of the flower, and how they do it.

In England, we can only look upon it as an ornamental stove creeper, and as such we may safely commend it to the notice of the curious as one of the most distinct and handsome of its race.—*M. T. M., The Gardeners' Chronicle.*



ARISTOLOCHIA LONGECAUDATA—LEAF, FLOWER, AND FLORAL DETAILS.

Color of flower, cream, striped and marbled with deep velvety purple. Section of flower, showing mechanism for fertilization. Column magnified 4 diam.

PETER KIEFFER.

PETER KIEFFER was the originator of the Kieffer pear. All over the world of gardening probably the Kieffer pear is known. Certainly in the United States, hundreds of thousands have been planted, and hundreds of thousands of dollars realized from its sale. The owner of the tree, a near neighbor of mine, received probably but a few hundred, if that much. It seems that the great circle that has derived so much pleasure and profit from his work should at least know something of the man who died on November 7, at his home in the suburbs of Philadelphia. He was a Frenchman, born in Alsace, June 29, 1812. He arrived in New York, December, 1834. Failing in employment there, he walked through snow two feet deep to Philadelphia, 100 miles, and obtained a situation as gardener to the famous agriculturist James Gowen, of Mount Airy, near here, where he married and finally bought a few acres, and started a little market garden and small nursery.

He was gifted with a superior knowledge of gardening as an art and as a science, but so exceedingly modest and childlike in all his intercourse with his fellow men, that few knew of his superior accomplishments. He had some relative at Bollwyller, in France, I believe some connection with Bauman, so well known to gardeners of the past generation, and his annual great delight was to receive a package of rare plants—chiefly of trees and shrubs. A very little money seemed a great deal to him, and those who were lucky enough to have the acquaintance of the good man got many a bargain in rare plants from him.

All around Philadelphia are numerous rare trees and plants, the history of which no one knows, and the mystery is usually finally settled by the remark "Probably something introduced by Peter Kieffer." The sand pear of Japan, so far as relates to the older trees growing in this section of America, if not in other parts, he certainly introduced. Numerous trees were fruiting here between thirty and forty years ago—the fruit regarded as of no or little culinary value, but much esteemed for its delightful perfume. Mr. Kieffer raised seedlings from his tree, which were sold yearly from his little nursery. His tree grew close to a Bartlett (your Williams' Bon Chretien), and the branches of the two interlaced. Some slight difference in one seedling was noted, and it was preserved from sale. This proved what is, from the above facts, reasonably believed to be a true hybrid, the Kieffer pear. The fine red cheek, and some general appearance to the Flemish Beauty, has caused the statement to appear in our pomological works that it is a hybrid with the Flemish Beauty. Mr. K. grafted and sold a few here and there for five dollars each; but though he distributed among his few horticultural friends annually fruit that would make the most cold-souled epicure leap with joy, no effort was made by any one to place it properly on the market. At length the great Centennial Exhibition came. Mr. Kieffer had some on exhibition; these excelled in size, beauty, flower—everything, indeed, for which any pear could possibly be esteemed.

The writer, who was secretary to the jury, can truly say that he remembers eating no pear like them. They had a medal, and a strong report in their favor; and Mr. Wm. Parry, a well known introducer of new fruits, made an arrangement with Mr. Kieffer for grafts. In this way the variety got regularly into commerce. It may be said that gardening is no longer an art here, as it was in Mr. Kieffer's day. A fruit has to be "hardy," and "first class"; just as nature gives it to you. You plant the tree, but to a very great extent, it must for ever after be able to take care of itself. Mr. Kieffer knew how to gather and how to cure his pears; year by year, since 1868, when the Kieffer pear first fruited, you could go to his house, and out of his cellar he would bring you fruits, the like of which you might not find elsewhere. Few, if any, can get Kieffer pears as Kieffer had them, and the art has died with him. In our fruit list it is simply classed as "valuable for market purposes," and the fruit chapters tell us it is "a very variable kind." Philadelphia is being fast covered with buildings over its vast area of 120 square miles. The original Kieffer pear tree is still standing in Mr. Kieffer's grounds, but it will probably not be many years before the march of improvement will bid it begone.—*Thomas Meehan, Germantown, Pa., in The Gardeners' Chronicle.*

AID TO ASTRONOMICAL RESEARCH.

A CIRCULAR was issued last summer announcing the gift by Miss Bruce of six thousand dollars ($6000) for aiding astronomical research. No restrictions were made upon its expenditure which seemed likely to limit its usefulness, and astronomers of all countries were invited to make applications for portions of it, and suggestions as to the best method of using it. Eighty-four replies have been received, and with the advice of the donor the entire sum has been divided so as to aid the following undertakings:

3. Professor W. W. Payne, Director of the Carleton College Observatory. Illustrations of the Sidereal Messenger.
6. Professor Simon Newcomb, Superintendent of the American Nautical Almanac. Discussion of contact observations of Venus during its transits in 1874 and 1882.
16. Dr. J. Plassmann, Warendorf. For printing observations of meteors and variable stars.
23. Professor H. Bruns, Treasurer of the Astronomische Gesellschaft. To the Astronomische Gesellschaft for the preparation of Tables according to Gylden's method for computing the elements of the asteroids.
27. Professor J. J. Astrand, Director of the observatory, Bergen, Norway. Tables for solving Kepler's Problem.
29. Professor J. C. Adams, Director of the Cambridge Observatory, England. Spectroscope for the 27 inch telescope of the Cambridge Observatory.
36. Professor A. Hirsch, Secretary of the International Geodetic Association. To send an expedition to the Sandwich Islands to study the annual variation, if any, in latitude.
40. H. H. Turner, Esq., Assistant in Greenwich Observatory. Preparing Tables for computing star corrections.
45. Professor Edward S. Holden, Director of the Lick Observatory. Reduction of meridian observations of Struve stars.
46. Professor Lewis Swift, Director of the Warner Observatory. Photographic apparatus for fifteen inch telescope.
54. Professor Norman Hogson, Director of Madras Observatory, Publication of old observations of variable stars, planets, and asteroids.
57. Dr. Ludwig Struve, Astronomer at Dorpat Observatory. Reduction of observations of occultations during the lunar eclipse of Jan. 28, 1888, collected by the Pulkowa Observatory.
60. Dr. David Gill, Director of the observatory of the Cape of Good Hope. (1) Reduction of heliometer observations of asteroids. (2) Apparatus for engraving star charts of the Southern Durchmusterung.
78. Professor A. Safarik, Prague. Photometer for measuring variable stars.
79. Professor Henry A. Rowland, Johns Hopkins University. Identification of metals in the solar spectrum.

Of the remaining replies many describe wants no less urgent than those named above. Some relate to meteorology or physics rather than to astronomy, some to work already completed, and others were received too late to be included. Two important cases may be

specially mentioned. In each of them an appropriation of a part of the sum required would have been made. But in one, in our own country, an active and honored friend of the science undertakes the whole. And in the other, in France, the generous M. Bischoffsheim, already known as the founder of the great observatory at Nice, ignoring political boundaries and the comparative selfishness of patriotism, came forward and gave the entire sum required. The same sky overarches us all. It is to be hoped that the above named, and other foreign institutions, will obtain more important aid from neighbors when these become aware how highly the work of their scientists is appreciated in this country. The replies not enumerated above are confidential, and cannot be mentioned except by the permission of the writers. But they have placed me in possession of important information regarding the present needs of astronomers. In several cases a skillful astronomer is attached to a college which has no money for astronomical investigation. He has planned for years a research in the hope that some day he may be able to carry it out. A few hundred dollars would enable him to do this, and he offers to give his own time, taken from his hours of rest, if only he can carry out his cherished plans.

Such valuable results could be attained by the expenditure of a few thousand dollars, that no opportunity should be missed to secure this end. Fortunately, the number of persons in the United States able and willing to give liberally to aid astronomy is very large. It is hoped that some of them may be inclined to consider the case here presented. The income derived from a gift of one hundred thousand dollars would provide every year for several cases like those named above. A few thousand dollars would provide immediately for the most important of the cases now requiring aid. The results of such a gift would be very far reaching, and would be attained without delay. Correspondence is invited with those wishing to aid any department of astronomy, either in large or small sums, by direct gift or by bequest. EDWARD C. PICKERING.

Harvard College Observatory,
Cambridge, Mass., U. S. A., November 11, 1890.

ANTARCTIC EXPLORATION.

By G. S. GRIFFITHS.

THE following address, on "The Objects of Antarctic Exploration," was, says *Nature*, delivered at the annual meeting of the Bankers' Institute of Australasia, at Melbourne, on Wednesday, August 27, by Mr. G. S. Griffiths, F.G.S., F.R.G.S., his Excellency the Earl of Hopetoun being in the chair.

Mr. Griffiths said:

My experience during the four years which have elapsed since this project was first mooted in Melbourne is that any reference to the subject is sure to be met with the query, *Cui bono?* What good can it do? What benefit can come from it? What is the object to be served by such an expedition?

In setting myself to the task of answering these questions, let me observe that it would indeed be strange if an unexplored region, 8,000,000 square miles in area—twice the size of Europe—and grouped around the axis of rotation and the magnetic pole, could fail to yield to investigators some novel and valuable information.

But when we notice that the circle is engirdled without by peculiar physical conditions which must be correlated to special physical conditions within, speculation is exchanged for a confident belief that an adequate reward must await the skilled explorer. The expected additions to the geography of the region are, of all the knowledge that is to be sought for there, the least valuable. Where so many of the physical features of the country—the hills, the valleys, and the drainage lines—have been buried beneath the snow of ages, a naked outline, a bare skeleton of a map, is the utmost that can be delineated. Still, even such knowledge as this has a distinct value, and as it can be acquired by the explorers as they proceed about their more important researches, its relatively small value ought not to be admitted as a complete objection to any enterprise which has other objects of importance.

Our present acquaintance with the geography of the region is excessively limited. Ross just viewed the coasts of Victoria Land, between 163° E. and 160° W. long. He trod its barren strand twice, but on each occasion for a few minutes only. From the adjacent gulf he measured the heights of its volcanoes, and from its offing he sketched the walls of its icy barrier. Wilkes traced on our map a shore line from 97° E. to 167° E. long, and he backed it up with a range of mountains, but he landed nowhere. Subsequently Ross sailed over the site assigned to part of this land, and hove his lead 600 fathoms deep where Wilkes had drawn a mountain. He tells us that the weather was so very clear that had high land been within 70 miles of that position he must have seen it ("Ross' Voyage," 1278).

More recently Nares, in the Challenger, tested another part of Wilkes' coast line, and with a like result. And these circumstances throw doubts upon the value of his reported discoveries. D'Urville subsequently followed a bold shore for a distance of about 300 miles from 136° E. to 142° E. long., while in 67° S. lat., and between 45° E. and 60° E. long., are Enderby's and Kemp's lands. Again, there is land to the south of the Horn, which trends from 45° to 75° S. lat. These few discontinuous coast lines comprise all our scanty knowledge of the Antarctic land. It will be seen from these facts that the principal geographical problem awaiting solution in these regions is the interconnection of these scattered shores. The question is, Do they constitute parts of a continent, or are they, like the coasts of Greenland, portions of an archipelago, smothered under an overload of frozen snow, which conceals their insularity? Ross inclined to the latter view, and he believed that a wide channel leading toward the pole existed between North Cape and the Balleny Islands ("Ross' Voyage," 1221). This view was also held by the late Sir Wyville Thomson. A series of careful observations upon the local currents might throw some light upon these questions. Ross notes several such in his log. Off Possession Island a current, running southward, took the ships to windward (*ibid.*, 1195). Off Coulman Island another drifted them in the same direction, at the rate of eighteen miles a day (*ibid.*, 1204). A three quarter knot northerly current was felt off the barrier, and may have issued from beneath some part of it. Such isolated observations are of little value, but they were multiplied, and were the currents correlated with the winds experienced, the information thus obtained might enable us to detect the existence of straits, even where the channels themselves are masked by icy barriers.

Finally, it is calculated that the center of the polar ice cap must be three miles, and may be twelve miles, deep, and that, the material of this ice mountain being viscous, its base must spread out under the crushing pressure of the weight of its center. The extrusive movement thus set up is supposed to thrust the ice cliffs off the land at the rate of a quarter of a mile per annum.

These are some of the geographical questions which await settlement.

In the geology of this region we have another subject replete with interest. The lofty volcanoes of Victoria Land must present peculiar features. Nowhere else do fire and frost divide the sway so completely.

Ross saw Erebus belching out lava and ashes over the snow and ice which coated its flanks. This circumstance leads us to speculate on the strata that would result from the alternate fall of snow and ashes during long periods and under a low temperature. Volcanoes are built up, as contra-distinguished from other mountains, which result from elevation or erosion. They consist of *debris* piled round a vent. Lava and ashes surrounded the crater in alternate layers. But in this polar region the snowfall must be taken into account as well as the ash deposit and the lava flow. It may be thought that any volcanic ejecta would speedily melt the snow upon which they fell, but this does not by any means necessarily follow. Volcanic ash, the most widespread and most abundant material ejected, falls comparatively cold, cakes, and then forms one of the most effective non-conductors known. When such a layer, a few inches thick, is spread over snow, even molten lava may flow over it without melting the snow beneath. This may seem to be incredible, but it has been observed to occur. In 1828, Lyell saw on the flanks of Etna a glacier sealed up under a crust of lava. Now, the Antarctic is the region of thick ribbed ice. All exposed surfaces are quickly covered with snow. Snow-falls, fish-falls, and lava flows must have been heaping themselves up around the craters during unknown ages. What has been the result? Has the viscosity of the ice been modified by the intercalation of beds of rigid lava and of hard-set ash? Does the growing mass tend to pile up or to settle down and spread out? Is the ice wasted by evaporation, or does the ash layer preserve it against this mode of dissipation? These interesting questions can be studied round the South Pole, and perhaps nowhere else so well.

Another question of interest, as bearing upon the location of the great Antarctic continent, which it is now certain existed in the secondary period of geologists, is the nature of the rocks upon which the lowest of these lava beds rest. If they can be discovered, and if they then be found to be sedimentary rocks such as slates and sandstones, or plutonic rocks such as granite, they will at once afford us some data to go upon, for the surface exposure of granite signifies that the locality has been part of a continental land sufficiently long for the weathering and removal of the many thousands of feet of sedimentary rocks which of necessity overlie crystalline rocks during their genesis, while the presence of sedimentary rocks implies the sometime proximity of a continent from the surfaces of which alone these sediments, as rainwash, could have been derived.

As ancient slate rocks have already been discovered in the ice-clad South Georgias, and as the drag nets of the Erebus and the Challenger have brought up from the beds of these icy seas fragments of sandstones, slates and granite, as well as the typical blue mud which invariably fringes continental land, there is every reason to expect that such strata will be found.

Wherever the state of the snow will permit, the polar mountains should be searched for basaltic dikes, in the hope that masses of specular iron and nickel might be found, similar to those discovered by Nordenskiold, at Ovifac, in North Greenland. The interest taken in these metallic masses arises from the fact that they alone, of all the rocks of the earth, resemble those masses of extra terrestrial origin which we know as meteorites. Such bodies of unoxidized metal are unknown elsewhere in the mass, and why they are peculiar to the Arctic it is hard to say. Should similar masses be found within the Antarctic, a fresh stimulus would be given to speculation. Geologists would have to consider whether the oxidized strata of the earth's crust thin out at the poles, whether in such a case the thinning is due to severe local erosion, or to the protection against oxygen afforded to the surface of the polar regions by their ice caps, or to what other cause. Such discoveries would add someting to our knowledge of the materials of the interior of our globe and their relation to those of meteorites.

Still looking for fresh knowledge in the same direction, a series of pendulum observations should be taken at points as near as possible to the pole. Within the Arctic circle the pendulum makes about 240 more vibrations per day than it does at the equator. The vibrations increase in number there because the force of gravity at the earth's surface is more intense in that area, and this again is believed to be due to the oblateness of that part of the earth's figure, but it might be caused by the bodily approach to the surface at the poles of the masses of dense ultra-basic rocks just referred to. Thus, pendulum experiments may reveal to us the earth's figure, and a series of such observations, recorded from such a vast and untried area, must yield important data for the physicist to work up. We should probably learn from such investigations whether the earth's figure is as much flattened at the Antarctic as it is known to be at the Arctic.

We now know that in the past the north polar regions have enjoyed a temperate climate more than once.

Abundant seams of Palæozoic coal, large deposits of fossiliferous Jurassic rocks, and extensive Eocene beds containing the remains of evergreen and deciduous trees and flowering plants, occur far within the Arctic circle.

This circumstance leads us to wonder whether the corresponding southern latitudes have ever experienced similar climatic vicissitudes. Conclusive evidence on this point it is difficult to get, but competent biologists who have examined the floras and faunas of South Africa and Australia, of New Zealand, South America, and the isolated islets of the Southern Ocean, find features which absolutely involve the existence of an extensive Antarctic land—a land which must have been clothed with a varied vegetation, and have been alive with beasts, birds, and insects. As it also had had its fresh-water fishes, it must have had its rivers flowing and not frost bound, and in those circumstances we again see indications of a modified Antarctic climate. Let us briefly consider some of the evidence for the existence of this continent. We are told by Prof. Hutton, of Christchurch, that 44 per cent. of the New Zealand flòra is of Antarctic origin.

The Auckland, Campbell, and Macquarie Islands all support Antarctic plants, some of which appear never to have reached New Zealand. New Zealand and South America have three flowering plants in common, also two fresh water fishes, five seaweeds, three marine crustaceans, one marine mollusk and one marine fish. Similarly New Zealand and Africa have certain common forms, and the floras and faunas of the Kerguelen, the Crozets, and the Marion Islands are almost identical, although in each case the islands are very small, and very isolated from each other and from the rest of the world. Tristan d'Acunha has 58 species of marine mollusca, of which number 13 are also found in South America, six or seven in New Zealand, and four in South Africa (Hutton's *Origin of New Zealand Flora and Fauna*). Temperate South America has 74 genera of plants in common with New Zealand and 11 of its species are identical (Wallace's *Island Life*). Penguins of the genus Eudyptes are common to South America and Australia (Wallace, *Dist. of Animals*, 1399). Three groups of fresh-water fishes are entirely confined to these two regions. Aphritis, a fresh water genus, has one species in Tasmania and two in Patagonia. Another small group of fishes known as the Haplochitonidæ inhabit Terra del Fuegia, the Falklands, and South Australia, and are not found elsewhere, while the genus Galaxias is confined to south temperate America, New Zealand, and Australia. Yet the lands which have these plants and animals in common are so widely separated from each other that they could not now possibly interchange their inhabitants. Certainly toward the equator they approach each other rather more, but even this fact fails to account for the present distribution, for, as Wallace has pointed out, "the heat loving reptilia afford hardly any indications of close affinity between the two regions" of South America and Australia, "while the cold-enduring amphibia and fresh water fishes offer them in abundance" (Wallace, *Dist. of Animals*, 1400). Thus we see that to the north interchange is prohibited by tropical heat, while it is barred to the south by a nearly shoreless circumpolar sea. Yet there must have been some means of intercommunication in the past, and it appears certain that it took the shape of a common fatherland for the various common forms from which they spread to the northern hemisphere. As this fatherland must have been accessible from all these scattered southern lands, its size and its disposition must have been such as would serve the emigrants either as a bridge or as a series of stepping stones. It must have been either a continent or an archipelago.

But a further and a peculiar interest attaches to this lost continent. Those who have any acquaintance with geology know that the placental mammalia —that is, animals which are classed with such higher forms of life as apes, cats, dogs, bears, horses, and oxen—appear very abruptly with the incoming of the Tertiary period. Now, judging by analogy, it is not likely that these creatures can have been developed out of Mesozoic forms with anything like the suddenness of their apparent entrance upon the scene. For such changes they must have required a long time, and an extensive region of the earth, and it is probable that each of them has a lengthy series of progenitors, which ultimately linked it back to lower forms.

Why, then, it is constantly asked, if this was the sequence of creation, do these missing links never turn up?

In reply to this query, it was suggested by Huxley that they may have been developed in some lost continent, the boundaries of which were gradually shifted by the slow elevation of the sea margin on one side and its simultaneous slow depression upon the other, so that there has always been in existence a large dry area with its live stock. This dry spot, with its fauna and flora, like a great raft or Noah's ark, moved with great slowness in whatever direction the great earth-undulation traveled. But to-day this area, with its fossil evidences, is a sea bottom, and Huxley supposes that the continent, which once occupied a part of the Pacific Ocean, is now represented by Asia.

This movement of land surface translation eastward eventually created a connection between this land and Africa and Europe, and if, when this happened, the mammalia spread rapidly over these countries, this circumstance would account for the abruptness of their appearance there.

Now, Mr. Blanford, the president of the Geological Society of London, in his annual address, recently delivered, advances matters a stage further, for he tells us that a growing acquaintance with the biology of the world leads naturalists to a believe that the placental mammalia, and other of the higher forms of terrestrial life, originated during the Mesozoic period, still further to the southward—that is to say, in the lost Antarctic continent, for the traces of which we desire to seek.

But it almost necessarily follows that wherever the mammalia were developed, there also man had his birthplace, and if these speculations should prove to have been well founded, we may have to shift the location of the Garden of Eden from the northern to the southern hemisphere.

I need hardly suggest to you that possibilities such as these must add greatly to our interest in the recovery of any traces of this mysterious region. This land appears to have sunk beneath the seas after the close of

the Mesozoic. Now the submergence of any mass of land will disturb the climatic equilibrium of that region, and the disappearance of an Antarctic continent would prove extremely potent in varying the climate of this hemisphere. For to-day the sun's rays fall on the South Polar regions to small purpose. The unstable sea absorbs the heat, and in wide and comparatively warm streams it carries off the caloric to the northern hemisphere, to raise its temperature at the expense of ours. But when extensive land received those same heat rays, its rigid surfaces, so to speak, tethered their caloric in this hemisphere, and thus when there was no mobile current to steer northward with it, warmth could accumulate and modify the climate.

Under the influence of such changes the icy mantle would be slowly rolled back toward the South Pole, and thus many plants and animals were able to live and multiply in latitudes that to-day are barren. What has undoubtedly occurred in the extreme north is equally possible in the extreme south. But if it did occur—if south polar lands, now ice bound, were then as prolific of life as Disco and Spitzbergen once were—then, like Spitzbergen and Disco, the unsubmerged remnants of this continent may still retain organic evidences of the fact in the shape of fossil-bearing beds, and the discovery of such deposits would confirm or confute such speculations as these. The key to the geological problem lies within the Antarctic circle, and to find it would be to recover some of the past history of the southern hemisphere. There is no reason to despair of discovering such evidence, as Dr. M'Cormack, in his account of Ross' voyage, records that portions of Victoria Land were free from snow, and therefore available for investigation; besides which their surface may still support some living forms, for they cannot be colder or bleaker than the peaks which rise out of the continental ice of north Greenland, and these, long held to be sterile, have recently disclosed the existence upon them of a rich though humble flora.

We have now to consider some important meteorological questions. If we look at the distribution of the atmosphere around the globe, we shall see that it is spread unequally.

It forms a stratum which is deeper within the tropics than about the poles and over the northern than over the southern hemisphere, so that the barometer normals fall more as we approach the Antarctic than they do when we near the Arctic. Maury, taking the known isobars as his guide, has calculated that the mean pressure at the North Pole is 29·1, but that it is only 28 at the south (Maury's "Meteorology," 259). In other words, the Antarctic circle is permanently much barer of atmosphere than any other part of the globe.

Again, if we consult a wind chart we shall see that both poles are marked as calm areas. Each is the dead center of a perpetual wind vortex, but the South Polar indraught is the stronger. Polarward winds blow across the 45th degree of north latitude for 189 days in the year, but across the 45th degree of south latitude for 209 days. And while they are drawn into the North Pole from over a disk-shaped area 5,500 miles in diameter, the South Polar indraught is felt throughout an area of 7,000 miles across. Lastly, the winds which circulate about the South Pole are more heavily charged with moisture than are the winds of corresponding parts of the other hemisphere. Now the extreme degree in which these three conditions—of a perpetual grand cyclone, a moist atmosphere, and a low barometer—co-operate without the Antarctic ought to produce, within it, an exceptional meteorological state, and the point to be determined is what that condition may be. Maury maintained that the conjunction will make the climate of the South Polar area milder than that of the north. His theory is that the saturated winds being drawn up to great heights within the Antarctic must then be eased of their moisture, and that simultaneously they must disengage vast quantities of latent heat; and it is because more heat must be liberated in this manner in the South Polar regions than in the north that he infers a less severe climate for the Antarctic. He estimates that the resultant relative differences between the two polar climates will be greater than that between a Canadian and an English winter (Maury's "Meteorology," p. 466). Ross reports that the South Polar summer is rather colder than that of the north, but still the southern winter may be less extreme, and so the mean temperature may be higher. If we examine the weather reports logged by Antarctic voyagers, instead of the temperature merely, the advantage still seems to rest with the south. In the first place, when the voyager enters the Antarctic, he sails out of a tempestuous zone into one of calms. To demonstrate the truth of this statement, I have made an abstract of Ross's log for the two months of January and February, 1841, which he spent within the Antarctic circle. To enable every one to understand it, it may be well to explain that the wind force is registered in figures from 0, which stands for a dead calm, up to 12, which represents a hurricane. I find that during these 60 days it never once blew with the force 8—that is, a fresh gale; only twice did it blow force 7, and then for only a half a day each time. Force 5 to 6—fresh to strong breezes—is logged on 21 days. Force 1 to 3—that is, gentle breezes—prevailed on 34 days. The mean wind force registered under the entire 60 days was 3·43—that is, only a four to five knot breeze. On 38 days, blue sky was logged. They never had a single fog, and on 11 days only was it even misty. On the other hand, snow fell almost every second day. We find such entries as these—"beautifully clear weather," and "atmosphere so extraordinarily clear that Mount Herschel, distant 90 miles, looked only 30 miles distant." And again, "land seen 120 miles distant, sky beautifully clear." Nor was this season exceptional, so far as we can tell, for Dr. M'Cormack, of the Erebus, in the third year of the voyage, and after they had left the Antarctic for the third and last time, enters in his diary the following remark. He says: "It is a curious thing that we have always met with the finest weather within the Antarctic circle; clear, cloudless sky, bright sun, light wind, and a long swell" (M'Cormack's "Antarctic Voyage," vol. i., p. 345). It would seem as if the stormy westerlies so familiar to all Australian visitors had given to the whole southern hemisphere a name for bad weather, which, as yet at least, has not been earned by the south polar regions. It is probable, too, that the almost continuous gloom and fog of the Arctic (Scoresby's "Arctic Regions," pp. 97 and 137) July and August have prejudiced seamen against the Antarctic summer. The true character of the climate of this region is one of the problems awaiting solution. Whatever its nature may be, the area is so large and so near to us that its meteorology must have a dominant influence on the climate of Australia, and on this fact the value of a knowledge of the weather of these parts must rest.

To turn to another branch of science, there are several questions relating to the earth's magnetism which require for their solution long-maintained and continuous observations within the Antarctic circle. The mean or permanent distribution of the world's magnetism is believed to depend upon causes acting in the interior of the earth, while the periodic variations of the needle probably arise from the superficial and subordinate currents produced by the daily and yearly variations in the temperature of the earth's surface. Other variations occur at irregular intervals, and these are supposed to be due to atmospheric electricity. All these different currents are excessively frequent and powerful about the poles, and a sufficient series of observations might enable physicists to differentiate the various kinds of currents, and to trace them to their several sources, whether internal, superficial, or meteoric. To do this properly at least one land observatory should be established for a period. In it the variation, dip, and intensity of the magnetic currents, as well as the momentary fluctuations, of these elements, would all be recorded. Fixed term days would be agreed on with the observatories of Australia, of the Cape, America, and Europe, and during these terms a concerted continuous watch would be kept up all round the globe to determine which vibrations were local and which general.

The present exact position of the principal south magnetic pole has also to be fixed, and data to be obtained from which to calculate the rate of changes in the future, and the same may be said of the foci of magnetic intensity and their movements. In relation to this part of the subject, Captain Creak recently reported to the British Association his conclusions in the following terms. He says: "Great advantage to the science of terrestrial magnetism would be derived from a new magnetic survey of the southern hemisphere extending from the parallel of 40° S. as far toward the geographical pole as possible."

Intimately connected with terrestrial magnetism are the phenomena of auroras. Their nature is very obscure, but quite recently a distinct advance has been made toward discovering some of the laws which regulate them. Thanks to the labors of Dr. Sophus Tromholt, who has spent a year within the Arctic circle studying them, we now know that these movements are not as eccentric as they have hitherto appeared to be. He tells us that the Aurora Borealis, with its crown of many lights, encircles the pole obliquely, and that it has its lower edge suspended above the earth at a height of from 50 to 100 miles, the mean of 18 trigonometrical measurements, taken with a base line of 50 miles, being 75 miles. The aurora forms a ring round the pole which changes its latitude four times a year. At the equinoxes it attains its greatest distance from the pole, and at midsummer and midwinter it approaches it most closely, and it has a zone of maximum intensity which is placed obliquely between the parallels of 60° and 70° N. The length of its meridional excursion varies from year to year, decreasing and increasing through tolerably regular periods, and reaching a maximum about every eleven years, when, also, its appearance simultaneously attains to its greatest brilliancy. Again, it has its regular yearly and daily movements or periods. At the winter solstice it reaches its maximum annual intensity, and it has its daily maximum at from 8 p. m. and 2 a. m., according to the latitude. Thus at Prague, in lat. 50° N., the lights appear at about 8.45 p. m.; at Upsala, lat. 60° N., at 9.30 p. m.; at Bossekop, 70° N., at 1.30 a. m. Now, while these data may be true for the northern hemisphere, it remains to be proved how far they apply to the southern. Indeed, seeing that the atmosphere of the latter region is moister and shallower than that of the former, it is probable that the phenomena would be modified. A systematic observation of the Aurora Australis at a number of stations in high latitudes is therefore desirable.

Whether or not there is any connection between auroral exhibitions and the weather is a disputed point. Tromholt believes that such a relationship is probable ("Under the Rays," 1283). He says that, "however clear the sky, it always became overcast immediately after a vivid exhibition, and it generally cleared again as quickly" ("Under the Rays," 1235). Payer declares that brilliant auroras were generally succeeded by bad weather ("Voyage of Tegelhoff," 1324), but that those which had a low altitude and little mobility appeared to precede calms. Ross remarks of a particular display that "it was followed by a fall of snow, as usual" ("Ross's Voyage," 1312). Scoresby appears to have formed the opinion that there is a relationship indicated by his experience. It is, therefore, allowable to regard the ultimate establishment of some connection between these two phenomena as a possible contingency. If, then, we look at the eleven-year cycle of auroral intensity from the meteorological point of view, it assumes a new interest, for these periods may coincide with the cycles of wet and dry seasons, which some meteorologists have deduced from the records of our Australian climate, and the culmination of the one might be related to some equivalent change in the other. For if a solitary auroral display be followed by a lowered sky, surely a period of continuous auroras might give rise to a period of continuous cloudy weather, with rain and snow. Fritz considers that he has established this eleven-year cycle upon the strength of auroral records extending from 1583 to 1874, and his deductions have been verified by others.

In January, 1886, we had a wide-spread and heavy rainfall, and also an auroral display seen only at Hobart, but which was sufficiently powerful to totally suspend communication over all the telegraph lines situated between Tasmania and the China coast. This sensitiveness upon the part of the electric currents to auroral excitation is not novel, for long experience on the telegraph wires of Scandinavia has shown that there is such a delicate sympathy between them that the electric wires there manifest the same daily and yearly periods of activity as those that mark the auroras. The current that reveals itself in fire in the higher regions of the atmosphere is precisely the same current that plagues the operator in his office. Therefore, in the records of these troublesome earth-currents now being accumulated at the observatory by Mr. Ellery we are collecting valuable data, which may possibly enable the physicist to count the unseen auroras of the Antarctic, to calculate their periods of activity and lethargy, and, again, to check these with our seasons. But it need hardly be said that the observations which may be made in the higher latitudes and directly under the rays of the Aurora Australis will have the greater value, because it is only near the zone of maximum auroral intensity that the phenomena are manifested in all their aspects. In this periodicity of the southern aurora I have named the last scientific problem to which I had to direct your attention, and I would point out that if its determination should give to us any clew to the changes in the Australian seasons which would enable us to forecast their mutations in any degree, it would give to us, in conducting those great interests of the country which depend for their success upon the annual rainfall, an advantage which would be worth, many times over, all the cost of the expeditions necessary to establish it.

Finally, there is a commercial object to be served by Antarctic exploration, and it is to be found in the establishment of a whaling trade between this region and Australia. The price of whalebone has now risen to the large sum of £2,000 a ton, which adds greatly to the possibilities of securing to the whalers a profitable return. Sir James Ross and his officers have left it on record that the whale of commerce was seen by them in these seas, beyond the possibility of a mistake.

They have stated that the animals were large, and very tame, and that they could have been caught in large numbers. Within the last few years whales have been getting very scarce in the Arctic, and in consequence of this two of the most successful of the whaling masters of the present day, Captains David and John Gray, of Peterhead, Scotland, have devoted some labor to collecting all the data relating to this question, and they have consulted such survivors of Ross' expedition as are still available. They have published the results of their investigations in a pamphlet, in which they urge the establishment of the fishery strongly, and they state their conclusions in the following words. They say:

"We think it is established beyond doubt that whales of a species similar to the right or Greenland whale, found in high northern latitudes, exist in great numbers in the Antarctic seas, and that the establishment of a whale fishery within that area would be attended with successful and profitable results."

It is not necessary for me to add anything to the opinion of such experts in the business. All I desire to say is that if such a fishery were created, with its headquarters in Melbourne, it would probably be a material addition to our prosperity, and it would soon increase our population by causing the families of the hardy seamen who would man the fleet to remove from their homes in Shetland and Orkney and the Scotch coasts, and settle here.

In conclusion, I venture to submit that I have been able to point to good and substantial objects, both scientific and commercial, to justify a renewal of Antarctic research, and I feel assured that nothing could bring to us greater distinction in the eyes of the whole civilized world than such an expedition, judiciously planned and skillfully carried out.

THE COAL FIELDS OF ALABAMA.*

By HENRY MCCALLEY, Assistant State Geologist.

THE coal measures of Alabama are of the expanded and flattened southwest end of the great coal basin of the Ohio or of the great Appalachian coal field.

They were once connected throughout and then formed almost one-fourth the entire area of the State, or some 10,000 square miles. Things were thus at the time of the great Appalachian revolution, when there was pushed up across them, in a general northeast and southwest direction, a series of long parallel anticlinal ridges or mountains that have since been washed out into the present well known anticlinal valleys which now separate the measures into several distinct parts.

These parts are all made up of a succession of sandstones, conglomerates, shales, clays, coals, and a little impure limestone, locally at least, at several horizons.

These different parts were named by Prof. Tuomy in 1849, from the rivers which drain them, the *Warrior*, the *Cahaba* and the *Coosa* coal fields.

These coal fields, though once but parts of one and the same field, are now quite different as to their geological structure and topographical features. They have many advantages, the most important of which are their richness in good workable seams of coal, the ease and cheapness with which these coals can be mined and gotten to market, their nearness to the vast deposits of iron ores and limestones in the narrow anticlinal valleys that separate them, and their most favorable location, for, as has been said, they are surrounded on three sides by coalless areas, and are the nearest coal fields to the Gulf of Mexico and the Atlantic ports south of Charleston. Their most productive areas have also the great advantages of being, not on the tops of high mountains, but of comparatively low areas, with rivers winding through them, that can be made navigable the year round for steam tugs and coal barges.

The Warrior Coal Field.—This field embraces all the coal measures in Alabama that are drained by the Warrior and Tennessee Rivers. It also includes the Lookout Mountain coal field, which is drained by tributaries to the Coosa River. Its area, as thus defined, is some 7 800 square miles, and is over ten times larger than the other two fields combined. It is the most northwestern of the Alabama coal fields, and for the sake of convenience has been divided into a *plateau or table land area* and a *basin area* without any distinct line of demarkation between the two, the one gradually merging into the other.

The plateau or table land area is the northeast half of the field, and embraces what is locally known as the Cumberland Plateau (north of the Tennessee River), Sand Mountain, Raccoon Mountain, Blount Mountain, and Lookout Mountain (south of that river). Its area is some 4,500 square miles. It is most elevated in the

* A paper read before the American Geological Society, Washington, Dec. 29-31, 1890.

northeast corner of the State, where it is from 1,350 to 1,850 feet above tide water level, and from 350 to 850 above the adjacent valleys. Its coal measures vary in thickness from 50 to 2,500 feet, and its coal seams from one to eleven.

The *basin area* is the southwest half of the field, and embraces some 3,300 square miles. Its strata have a slight general dip to the southwest, and so its coal measures thicken in that direction to the southwest end of the basin or field at Tuscaloosa, where they become entirely covered up or hid by the cretaceous formation. Its most southwestern strata or, in fact, the most southwestern strata of the great Appalachian coal field, so far as they can be seen, are in the Warrior River, just below the bridge at Tuscaloosa. Provided the strata retain the thickness of their outcrops, the coal measures at and near Tuscaloosa must be near 5,000 ft. in thickness. These thickest measures have in them some 50 seams of coal, ranging in thickness from a few inches to 14 ft. and having a combined thickness of coal of about 125 ft.

These coals can be mined just as easily and just as cheaply as the coals of any other coal field, because the physical features of the country, the small angle of dip of the coals and the structure of the coals are all conducive to easy and cheap mining.

The transportation facilities for a considerable portion of this field are now good. It has seven railroad connections. It has also a river length within its basin of 100 miles that can be made navigable the year round for steam tugs and coal barges.

Cahaba Coal Field.—This is the central coal field of Alabama. It is a long narrow field, with a length from northeast to southwest of some 60 miles and a maximum width from northwest to southeast of about 15 miles. It gradually widens toward the southwest and has an area of about 435 square miles. It is bounded on the northwest by a high bluff and vein of Millstone Grit and on the southeast by a big fault that brings in contact with its uppermost measures Cambrian strata. It has, according to Mr. Joseph Squire, M.E., a maximum thickness of coal measures of over 5,000 ft. and 49 seams of coal that have an average combined thickness of about 100 ft. of coal. These coals as a class appear to be harder and cleaner than those of the Warrior field, but then they have the great disadvantage of being much more highly inclined, much more faulty, and in a much more broken country. They have a bright and shining luster and are remarkable for their purity and dryness.

Much of this field has now good transportation facilities. It has railway connections with four great railway lines. It also has through its most productive areas a river that can be made navigable for steam tugs and coal barges.

The Coosa Coal Field.—This is the most southeastern, the smallest and the least known of the three coal fields of Alabama. It is a long, narrow field of some 60 miles in length and a maximum width of only about 6 miles. Its widest portion is near the northeast end, because there is cut off from the southwest end by a monoclinal valley and a fault a strip some 25 miles long by from 2 to 4 miles in width. The area of the entire field is about 250 square miles.

The maximum thickness of the coal measures of this field is something like 2,500 ft., though over much the greater part of the field these measures are considerably less than 500 ft. in thickness.

There are known in this field four seams of coal that, in places, range from 3 to 10 ft. in thickness and have a combined thickness of about 19 ft. of coal. These seams, however, over the greater part of the field are believed to be much too thin to be of any commercial value. These coals appear to be rather soft and friable for stocking, but well suited for coking.

This field is touched by only one railroad. Its northeast end, however, is cut through by the Coosa River which is navigable from Rome, Ga., down through its intersection of this field.

The identity of the coal seams of the different fields have not as yet been fully made out, though doubtless this can be done. It is believed that the Warrior and Cahaba fields have each a maximum thickness of coal measures of about 5,000 ft., and there is but little doubt but that each of them has about 50 separate seams of coal, with a combined thickness of at least 100 ft. of coal.

There is no estimating with any degree of nearness the amount of workable coal in these fields. Let it be sufficient to say that there is no danger of its giving out in many years to come.

The thicker seams have nearly always interstratified with their coals thin pastings of shale. These coals are all free-burning bituminous coals, though of almost every variety. Though some of them are highly bituminous or gas-making coals, while others, though free-burning coals, are very dry and almost like semi-anthracite coals, some of them are reported to be especially well fitted for coking and blacksmithing purposes, while others are better suited for heating and steaming purposes. Some of them are hard and bright and are well adapted to handling and stocking, while others are of a duller color and of a softer or more friable nature. Some of them are very pure and give but a very small amount of ash and clinker, while others are bony and slaty. They all, however, as a class give on chemical analyses as good compositions as the average bituminous coals of any other State. Many of them have interstratified in them thin sheets of mineral charcoal

Some of these coals have a vertical, flaggy structure or a regular *face and butt structure*, while others are divided up by joints into cubical and rhomboidal blocks, and others still are solid and compact throughout.

Though it may be said that coal mining in Alabama, on a scientific basis, dates back to only 1872, there is now within the State some of the largest bituminous coal plants on the face of the globe. The coal output in Alabama for 1872 was only about 11,000 tons and for 1889 it was about 4,000,000 tons of 2,000 lb. each.

The coals of Alabama are rendered especially valuable from their proximity to the vast deposits of red and brown iron ores, and of limestones, of the narrow anticlinal valleys that separate the different coal fields.

Coke.—Coke made from Alabama coals was shown only as recently as 1876 to be good for iron ore smelting, and now the coke industry of Alabama is the third largest of its kind in the United States. The number of coke ovens in operation in the State in August, 1890, was 4,607. Of these, 74 were of the "Thomas patent," which are equivalent to 105 of the *beehive* basis. So there was then in operation an equivalent of 4,662 beehive ovens. There were at that time, in August, 1890, in course of construction in the State 340 ovens.

The coke output in the State for 1880 was about 60,871 tons, and for 1889 it was about 1,000,000 tons. This coke is used principally for iron ore smelting within the State.

The coal fields of Alabama have in them some *black band iron ore*, some *clay iron stone*, the greatest abundance of *fire clay*, and good *building* and *paving stones* and good *grindstone* and *millstone materials*. They are also still for the most part covered by their *virgin forests* of hard and soft woods.

ON THE OCCURRENCE OF MEGALONYX JEFFERSONII (HARLAN) IN CENTRAL OHIO.*

By EDWARD ORTON.

DURING the present month a discovery of unusual interest has been made in the post-glacial deposits of Central Ohio. In digging a county ditch in Berlin Township, Holmes County, a number of bones of Megalonyx Jeffersonii have been found in an excellent state of preservation. I wish to put on record a preliminary account of the facts of their occurrence. The greater number of the bones was exhumed on Friday, Dec. 19. I saw them for the first time on Saturday last and I have thus far only had an hour or two to study them.

Situation.—The bones were found near the northern line of the township, about six miles east and a little north of Millersburg, the county seat. The location can be further described as approximately 40 miles north of Columbus and 60 miles east of the same place: its latitude is about 40 degrees and 35 minutes. The altitude of the swampy tract from which they were taken is approximately 1,050 ft. above tide, the surrounding hills rising to a height of 200 to 250 ft. above the swamp. The swamp above named is locally known as the "Berlin Plains." It belongs to the extreme southern border of the drift formations for this portion of the State, and thus lies distinctly within the limits of the terminal moraine; in fact, it is wholly due to topographical features imposed by the moraine. The till in the valley is not less than 200 ft. deep, as has been proved by recent borings. But the drift sheets on the hills in the immediate neighborhood are very thin, and in fact are mainly wanting, a few granite bowlders being the main representatives on the high grounds. In the valleys, however, the moraine assumes its typical features, ridges of sand and gravel being pushed out to the southward in crescentic form, leaving numerous undrained basins, from some of which the water still sinks away as fast as it is received, and others of which have become shallow ponds, or swamps, from which the water finds its way out by means of the common drainage system of the country, and generally by very sluggish outflows. The beavers took possession of these outlets at many points and built their dams across them, raising the level of the water temporarily in this way.

The particular "plains" with which we are here concerned comprise about 300 acres in extent, forming parts of two or three farms. The surface of the swamp is a black muck of a vegetable origin, containing besides many twigs and roots of the plants that formerly occupied the swamp. The thickness of the muck in the edge of the swamp, which is the only portion yet traversed by the ditch, ranges from 4 to 5 ft. The muck is underlaid by a bed of marl, made up of clay, vegetable remains and numerous fresh water and land shells belonging to living species, among which Planorbis, Succinea, and other common varieties are to be recognized.

The ditch which is to drain the plains was begun some months ago and the digging was kept up until about the 20th of the present month, when the snow fell in such quantity as to interrupt the work for the winter. About three weeks since several bones were thrown out in the excavation that immediately attracted the attention of the workmen; a claw of unusual character was the most marked of this first find. The bones were taken by the county engineer to Millersburg, the county seat, and attracted a good deal of interest and attention there. They were referred with considerable sagacity by the local representatives of science in the village of Millersburg to Megalonyx. W. S. Hanna, Esq., ex-county surveyor, who had laid out the ditch in question and who had been in charge of the work until recently, took from the first a deep and intelligent interest in the discovery. Under his pilotage, a half day's work was undertaken on Friday, the 19th Dec., by the force of laborers employed on the ditch, in making further excavation near the point where the first bones were found. The search was successful to a high degree and almost from the beginning. One of the first bones found in this new work was the massive femur. Presently the other femur was unearthed and soon after that a tibia and two fibulas were added to the list. The last named bones have not before been found, so far as my information goes; at least they are not represented in Leidy's classic memoir. To this list there were added before nightfall of our shortest day five dorsal or lumbar vertebræ, one radius, one clavicle, the two calcaneum or heel bones, eleven claws, three teeth, the hyoid bone, many of the tarsal and carpal series and many fragments besides, the total number of bones and fragments making 100 up to the present time. Among the fragments, there is no doubt much interesting material for the study of the anatomist.

The bones are mainly found in the marl, and none of them at a greater depth than 10 inches in this deposit. A few projected into the overlying muck, and in this case they were invariably found in defective state as compared with the latter, having lost something of their substance and even of their form.

Condition.—As to the condition of the bones found in the marls, superlatives would be in place in describing them. After their long interment, they would seem to have scarcely passed even yet beyond the condition of soup bones. This excellent state of preservation seems common to the entire family to which this specimen belongs. I have not had time, as the account above given will show, to have had a chemical analysis made of the bones as yet, but I am sure that the phosphates have been replaced to but a small extent at the most.

Identification.—As to the identification of the bones as those of Megalonyx Jeffersonii, made first by the village geologists of Millersburg, there can, I presume, be no question. They agree closely with Leidy's descriptions, as far as these descriptions go. It is to be regretted that the bones of the head and anterior extremities have not yet been brought to light. There is good reason to expect that the pelvis will be disinterred in the search that is presently to be resumed. As for the head and the bones of the shoulder girdle, there is perhaps less ground for a hopeful view. There seems some reason to fear that they were left projecting into the muck, and thus became decomposed. The bones that have been found thus far were not in contact, but occupied a space of something more than a square rod.

The megalonyx makes an important addition to the post-glacial fauna of Ohio. We have found before the mastodon, the elephant, and giant beaver, the two former in considerable numbers, but this is the first occurrence of the great sloths, so far as my information goes, that has been reported in the valley of Ohio and its tributaries, north of the river itself. Big Bone Lick, in Kentucky, has furnished the most northerly specimens of the genus up to the present time. On the Atlantic slope megalonyx has been proved to have reached about the same latitude that I have here reported, namely, 30 degrees and 40 minutes, but in the Ohio valley it has been carried northward by the recent find fully one and one-half degrees of latitude.

These bones bring vividly before us one of the most surprising chapters of the paleontological revelation; a revelation which is made up of surprises. In 1789 a truly gigantic skeleton was found in the pampas of the La Plata district of South America, and was presently sent across the Atlantic. It is now safely housed in the Royal Museum of Madrid. The bones were the most massive known in the animal kingdom at that time. The teeth fell into the hands of the founder of this branch of geological science, viz, paleontology, Baron Cuvier, and he declared them to be the teeth of a herbivorous and probably a leaf-eating mammal, nearly allied to the sloth of the South American forests. By what possible reference of this monstrous skeleton could a greater surprise have been given to the naturalists of that day? From the insignificant arboreal animal that passes its life among the branches of the tropical forests, almost helpless and destitute of the power of locomotion when upon the ground, an animal that Buffon was accustomed to ridicule as a mal-creation, from this insignificant creature to a monster whose thigh bones had three times the volume of the same bones in the largest elephant, it taxed the faith of even the naturalists to make the transition; but every detail of the structure has confirmed and established the sagacious interpretation, and a new family was thus entered into the records of the recent past.

The first addition to the Megatherium family came from an unexpected source and in a way interesting for us to note. In 1798, President Thomas Jefferson obtained possession of some animal remains of unusual character that were discovered in a limestone cave in Greenbrier county, Virginia. A claw that was included among the remains attracted his particular attention and was made the basis of a paper presented in the year above named to the American Philosophical Society of Philadelphia, in which the bones were described, and to the animal to which they belonged a name was given. The name was based on the claw above referred to.

The "small Latin and less Greek" of the president were still adequate to the production of the generic name *Megalonyx*, "Great Claw." It would make the bones of the founder of American democracy turn in the grave that holds them to say that this animal had a *royal* christening, but certainly the royal christening was illustrious.

We are happy to mark in this city, given over largely to politics and statesmanship, one of the few connections between science and statesmen, certainly between paleontology and statesmen. Of all the tribes of life that have been preserved in the rocks of the continent during its long history, there is certainly but one that has been described and named by a president of the United States, and that one I am happy to bring anew to the attention of the geologists of America, at the Washington meeting. It is doubly honored by securing the name of the great statesman in its specific designation, *Megalonyx Jeffersonii*. It is a small matter that the illustrious author mistook the character of the claw that he discovered and referred it to a carnivorous animal. We would condone greater mistakes than this in our statesmen and presidents if they would turn their attention to paleontology. Indeed, are we not all obliged to confess as unfortunate or even worse mistakes of our own? The description of this fossil comes, as we are well aware, from the pen of the veteran paleontologist of the United States in the department of vertebrate geology, Dr. Joseph Leidy, "*nomen clarum et venerabile*." It may be truly said of him, "*non tetigit quod non adornavit*."

A find like this awakens strange questions as to origin and disappearance. Here was apparently full development. There is no hint in these bones that the eye had become dim or the natural force abated. The climate was growing somewhat milder in its *habitat* presumably; but there were colder lands still to the northward for the animal demanding such a climate.

Why should Megalonyx drop so abruptly from the ranks of life? Its probable slow rate of increase comes into the account. Not "one but a lion," but "one and a sloth." The questions remain unanswered. I will simply assure the society, in conclusion, that I shall take all possible pains to render this interesting find available to science, as far as may be, in every particular.

* A paper read before the Geological Society of America, at its Washington meeting, December, 1890.

HOME LIFE ON AN OSTRICH FARM.*

MRS. MARTIN and her husband started for South Africa in 1881, Mr. Martin having already served a long apprenticeship to ostrich farming. After a rest of a few months they took up a farm on the Karoo, about a day's journey from Port Elizabeth. The farm extended over 12,000 acres. We give here a few extracts:

* "Home Life on an Ostrich Farm." By Annie Martin. George Philip & Son, 32 Fleet Street.

In the early days of ostrich farming splendid fortunes were made. Then feathers were worth £100 per lb., the plumes of one bird at a single plucking realizing on an average £25. For a good pair of breeding birds £400 or even £500 was no uncommon price; and little chicks, only just out of the egg, were worth £10 each. Indeed, the unhatched eggs have sometimes been valued at the same amount. But since the supply has become so much greater than the demand, things are sadly changed for the farmer; our best pair of ostriches would not now sell for more than £12. And experience has taught us to look for no higher sum than thirty shillings for the feathers of the handsomest bird at one plucking. At the same time if a lady wishes to buy a good feather in London or in Paris, she has to pay nearly the same price as in former times.

There are not many young animals prettier than a little ostrich chick during the first few weeks of life. It has such a sweet, innocent baby face, such large eyes, and such a plump, round, little body. All its movements are comical, and there is an air of conceit and independence about the tiny creature which is most amusing. Instead of feathers it has a little rough coat which seems all made up of narrow strips of material, of as many different shades of brown and gray as there are in a tailor's pattern book, mixed with shreds of black; while the head and neck are apparently covered with the softest plush, striped and colored just like a tiger's skin on a small scale. On the whole, the little fellow on his first appearance in the world is not unlike a hedgehog on two legs, with a long neck.

On a large farm, when plucking is contemplated, it is anything but an easy matter to collect the birds; the gathering together of ours was generally a work of three days. Men have to be sent out in all directions to drive the birds, by twos and threes, from the far-off spots to which they have wandered. Little troops are gradually brought together and collected, first in a large inclosure, then in a small one, the plucking kraal, in which they are crowded together so closely that the most savage bird has no room to make himself disagreeable. Besides the gates through which the ostriches are driven into the kraal, there is an outlet at the opposite end through the "plucking box." This latter is a most useful invention, saving much time and trouble.

It is a very solid wooden box, in which, though there is just room for an ostrich to stand, he cannot possibly turn round, nor can he kick, the sides of the box being too high. At each end there is a stout door, and after more or less of a scuffle he is pushed in and the door slammed behind him. Then two operators, standing one on each side of the box, have him completely in their power, and with a few rapid snips of their shears his splendid wings are soon denuded of their long white plumes. These, to prevent their tips from being spoiled, are always cut before the quills are ripe. The stumps of the latter are allowed to remain some two or three months longer, until they are so ripe that they can be pulled out, generally by the teeth of the Kaffirs, without hurting the bird.

It is necessary to pull them, the feathers, which by their weight would have caused the stumps to fall out naturally at the right time, being gone. Some farmers, anxious to hurry on the next crop of feathers, are cruel enough to draw the stumps before they are ripe, but nature, as usual, resents the interference with her laws, and the feathers of birds which have been thus treated soon deteriorate. It is best to pluck only once a year. The tails, and the glossy black quills, are not cut but pulled out; this, every one says, does not hurt the birds, but there is an unpleasant tearing sound about the operation, which I think must make their eyes water.

The Martins, being great naturalists, laid down a fountain in their sitting room, but it was too much for them. Their pets were drowned in it. "Thousands of gnats, too, as noisy and nearly as venomous as mosquitoes, were brought into existence. And, romantic as was the idea of water plants growing in our little room, it had to be given up, and we contented ourselves with seeing our blue lotus in the form of a dado, on which we stenciled and painted them ourselves, in the true Egyptian conventional style, on alternate long and short stalks. We bordered the fireplace and decorated the tops of the doors with a few good old tiles from Damascus, Tunis, Algiers, and the Alhambra.

"Two beautiful hand-painted *sarongs*, brought by T—— from Java, formed each as perfect and artistic a *portière* as could be wished, and hid the ugly, ill-made doors. And with Turkish rugs, Oriental embroideries of all kinds, Moorish and Kabyle pottery, Algerian coffee tables and brackets, ancient Egyptian curiosities, and other trophies of travel we produced a general effect which, especially in South Africa, was not to be despised."

Among the numerous pets was a secretary bird. He was like a boa constrictor in his capacity for "putting himself outside" the animals on which he fed—lizards, rats, toads, frogs, fat juicy locusts, young chickens, alas! and some of the smaller pets, if left incautiously within his reach, even little kittens—all went down whole.

The last named animals were his favorite delicacy, and he was fortunate enough while at Walmer to get plenty of them. His enormous appetite, and our difficulty in satisfying it, were well known in the neighborhood, and the owners of several prolific cats, instead of drowning the superfluous progeny, bestowed them on us as offerings to Jacob. They were killed and given to him at the rate of one a day. Once, however, by an unlucky accident, one of them got into his clutches without the preliminary knock on the head, and the old barbarian swallowed it alive. For some minutes we could hear the poor thing mewing piteously in Jacob's interior, while he himself stood there listening and looking all round in a puzzled manner, to see where the noise came from. He evidently thought there was another kitten somewhere, and seemed much disappointed at not finding it.

Snakes are, it seems, indeed one of the greatest drawbacks to South African life. There are so many of them, they are of such deadly sorts and the obtrusive familiarity and utter absence of ceremony with which they come into the houses render the nerves of newly arrived inmates liable at any moment to receive a severe shock. After a time, of course, finding that every one you meet has some startling experience to relate of the discovery of intrusive snakes in all sorts of places where they were most unlooked for and least observable, you become somewhat inured to this unpleasant feature of colonial existence, and move about your house with the caution of one who would not be surprised to find a snake anywhere.—*Pall Mall Budget.*

LOCOMOTION IN WATER STUDIED BY PHOTOGRAPHY.

THE analysis of motion by means of successive and instantaneous photographs is already familiar to our readers, who know that by admitting light intermittingly into a photographic apparatus we can obtain upon a sensitized plate a series of images of an animal or an object in motion.

But, for this, it is necessary to operate in front of a dark background upon a very luminous object of small dimensions that is moving quickly enough to prevent the images from being superposed. Such conditions are not always easily fulfilled, so that, in this first form, photochronography was limited in its application. It was, therefore, necessary to modify this method in order to apply it to certain studies, such, for example, as the analysis of the different types of aquatic locomotion.

The animals experimented with swam in a glass-sided aquarium fitted into an aperture in a wall (Fig. 4).

The aquarium, directly illuminated by the light of the horizon, formed a very clear field upon which the various animals were outlined as silhouettes. Sometimes the external glass of the aquarium was covered by letting down an opaque shutter. Then, upon opening another shutter placed above the water, the brightly illuminated animals were seen standing out from a black field.

In most cases it is necessary to operate before the luminous ground. So it is not possible to receive several successive images upon an immovable plate, but it is necessary to cause the sensitized surface to move by starts, so as to bring before the objective points that are always new for each new image that is to be formed. For this purpose I use the Balagny flexible gelatino-bromide of silver film.

This film, which is both strong and flexible, is cut into a long and narrow strip which in the camera passes along at the focus of the objective, in unwinding from a supply bobbin and winding around a receiving one. The mechanism that moves the band is quite complicated and needs a special description.

Fig. 5 shows the arrangement of the apparatus. The objective, turned toward the right, has a slit in the center for the passage of the diaphragms, which, in revolving, allow the light to pass intermittingly.

When the small diaphragm makes one revolution the large one makes five revolutions, and it is then only that the apertures meet and the light passes. A bellows behind the objective allows the light to reach the sensitized film. The latter and the cylinders that guide it are contained in a hermetically closed compartment.

In Fig. 5, the interior of this compartment is rendered visible by the removal of the cover and a portion of the sides. Beneath, in a closed box, is the wheelwork that actuates all the parts of the apparatus, and that is wound up by a winch which is visible at the side.

The image is formed back of the bellows in an opening provided with a ground glass.

The focusing is done by means of a spy glass whose ocular is seen above the winch. Finally, the whole affair is supported by a tripod, which, when turned about, is converted into a device for carrying the apparatus.

The most important part to be described relates to the film on its introduction into the apparatus and the manner in which it is moved. Each analysis of a motion by photochronography gives rise to a long series of images and uses up a band of film. It is, therefore, necessary at each new experiment to remove the band that has been acted upon and to substitute another one for it. This substitution can be effected in the light by means of bobbins with coverings, which may be described as follows. At the extremity of each band of film (Fig. 6) are glued paper bands of the same width. One of these prolongations is red and the other is black. Each of them is about twenty inches in length.

In the laboratory, in red light, the band thus formed is wound upon a metal bobbin whose hollow it exactly fills. After winding, the bobbin presents on the exterior superposed layers of black paper, the opacity of which protects the sensitized film against the action of light.

Thus prepared, the supply bobbin may be handled in the light. In order to introduce it into the apparatus, several turns of the black covering are unwound and the extremity of the latter is fixed to an empty bobbin that we shall call the receiver, and upon which the band will wind in measure as it will have passed the focus of the objective. The regular application of the turns of the band around the bobbin is secured through compression rollers. When an experiment is finished the whole band will have passed from the supply bobbin, M (Fig. 5), to the receiving one. The latter will then present externally the red color of the covering, which, in turn, will protect the film from the action of light and permit it to be removed from the apparatus without danger. Owing to these two different colors, it is impossible to confound a bobbin that has been used with one that has not.

In order that the images shall be sharp, it is necessary

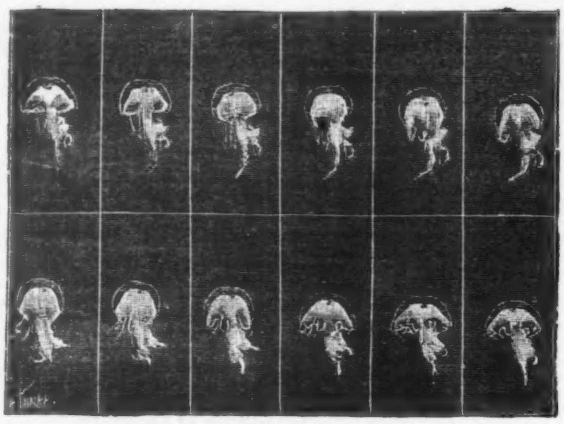


FIG. 1.—MOTIONS OF THE UMBRELLA OF THE MEDUSA.

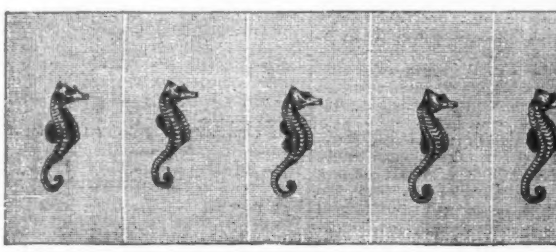


FIG. 2.—MOTIONS OF THE DORSAL FIN OF THE SEA HORSE.

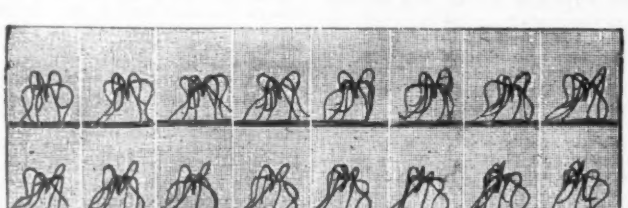


FIG. 3.—MOTIONS OF THE COMATULA.

that the surface upon which they form shall be perfectly immovable during the time of the exposure. Now, when we take a series of photographs at short intervals (30, 40, and even 50 times per second), the film and the wheelwork that carries it forward necessarily have a great velocity. In order to reproduce the phases of immobility of the sensitized band, it would not have done to think of stopping the massive pieces of the wheelwork, for that would have caused destructive shocks. On another hand, to have brought the film to a complete standstill while the wheelwork continued to act would have caused a breakage. I overcame these difficulties as follows:

At the place where the film is to pass before the objective, a compressing device applies it for an instant against the side of the camera and renders it immovable. But, beyond this point, the film is turned back upon a flexible plate before engaging with the roller that carries it along with a continuous motion. It follows from this that the film is rendered immovable in that part which receives the image, while the part situated farther along cedes to the action of the roller in causing a curvature of the spring upon which it is reflected. Things proceed, then, as if the film was extensible. After the short stoppage, which corresponds to an exposure, the bent spring straightens, and the band starts off very abruptly, and then continues to move forward with the mean velocity imparted to it by the roller, say about thirty inches per second.

FIG. 4.—ARRANGEMENT OF THE AQUARIUM FOR THE STUDY OF AQUATIC LOCOMOTION.

Beyond the roller, which is not shown in Fig. 5, and of which only the compressor, C, is seen, the film winds around the receiving bobbin until the whole of it has passed. There still remains one important condition to be fulfilled; it is necessary, before the film has begun to move, that the wheelwork shall have taken on its uniform velocity.

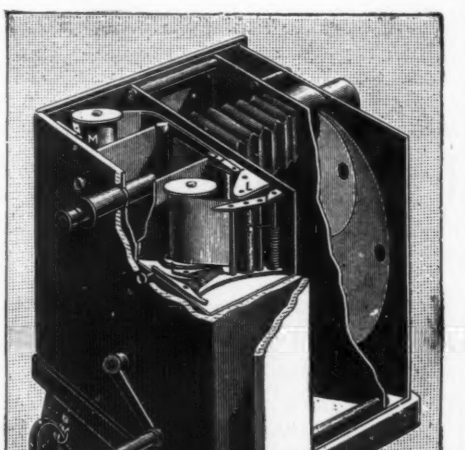


FIG. 5.—PHOTOCHRONOGRAPHIC APPARATUS.

In order to obtain such a result, the film fixed to the two bobbins and engaging with the roller is not compressed therein and is not submitted to a pull. This roller, in fact, is formed of a motive cylinder, whose perimeter is equal to the width of the image that it is desired to obtain, and of a compressing cylinder, C, which revolves passively, and which, at the moment that it is desired to begin the experiment, presses the film against the motive cylinder. At this moment the pull upon the film begins.

On another hand, if the receiving bobbin were continually revolving, it likewise would move the film forward. Such motion is arrested by a click, and then the motive arbor that traverses it revolves by friction in its interior. It is through the pressure upon each detent that we obtain the double effect of compressing the band in the roller and of freeing the receiving bobbin. The band carried along by the roller immediately begins its jerky motion, and in measure as it leaves the roller, winds around the receiving bobbin.

It is useless to describe the motor. I have constructed several types, some with weights, some with springs and others driven by electricity. In all, the action of the movable parts was so regulated that the pinching that arrests the film occurred exactly at the moment that the exposure had been made.

The apparatus just described is adapted for all sorts of studies, for the object whose images it takes can be placed at any distance and in all sorts of conditions as to illumination. It has seemed to me that one of the newest fields to explore is aquatic locomotion. In fact, it is not long ago that the use of the aquarium permitted of seeing with what a variety of means of locomotion the various kinds of aquatic animals (fishes, mollusks, crustaceans, etc.) propel themselves. It is unnecessary to say that, in order to obtain a knowledge of all those motions, observation is inadequate, and that it gives but a very imperfect idea of them. In many cases, the eye is incapable of following the motions of the propelling organs.

Figs. 1, 2, and 3 show some types of aquatic locomotion.

Motions of the Medusa.—The propulsion of this mollusk, as we know, is effected through the alternate contraction and dilatation of its umbrella. These motions are slow, and the eye can, without trouble, recognize their general characters, which recall those of the heart, and which produce also the expulsion of a liquid. Ten images per second suffice to obtain (as in Fig. 1) a pretty complete series of the phases of this motion. My photographs were obtained under the following conditions:

The back of the aquarium was dark, and the animal, brightly illuminated from above, stood out in a light color. These images, like all those that correspond to periodical motions, gain much by being examined in the zoetrope, wherein they reproduce, with absolute perfection, the aspect of the animal in motion.

Motion of the Hippocampus.—The principal propeller of this animal (which is vulgarly known as the sea horse) is a dorsal fin, which vibrates with such rapidity that it is almost invisible, and has an appearance analogous to that of the branches of a tuning fork in motion. With twenty images per second, it is seen (Fig. 2) that this vibration is undulatory, and we have before us the successive deviations of the lower, middle, and upper rays of the fin. In the present case, the undulation takes place from the bottom upward. These images are too small and too few to permit of grasping all the detail of the motions, but it would be easy to increase the number of them, and to make them larger by taking them from a shorter distance.

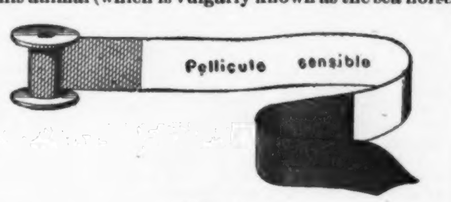


FIG. 6.

The Comatula (Fig. 3) is habitually fixed to the bottom of the aquarium, just as a plant is fixed to the earth by its roots. It therefore makes nothing but vague motions of the arms, which it rolls up and unrolls, and keeps its cirri apart. But if the animal be excited by means of a rod, it will be observed in a few moments to begin a strange motion which carries it to quite a distance.

In this kind of locomotion, the ten arms move alternately. Five of them rise and keep tightly pressed against the calyx, and the other five descend and separate from it. Besides, upon the arms that rise, the cirri are invisible, while upon those that descend they diverge in order to obtain a purchase upon the water. These motions of the cirri seem passive, like those of a valve that obeys the thrust of a liquid.

I have obtained images of a certain number of other aquatic species: the swimming of the eel and skate, the locomotion of the poulp, etc. These types of locomotion ought to be studied methodically, compared with each other, and considered in their relations with the conformation of the different animal species. It will, I hope, be a new element for the interpretation of the laws of animal morphology, which are still very obscure.—*E. J. Marey, in La Nature.*

[NATURE.]

HYDRAZOIC ACID—A NEW GAS.

A NEW gaseous compound of nitrogen and hydrogen has been obtained by Dr. Theodore Curtius, the discoverer of amidogen, and its nature and properties were described by him in the chemical section during the recent scientific meetings at Bremen. The composition of the gas is HN_3, and its constitution

$$\mathrm{H{-}N}\!<\!\begin{matrix}\mathrm{N}\\ \| \\ \mathrm{N}\end{matrix}$$

It is, in fact, the hydrogen compound corresponding to the well known diazobenzene imide of Griess,

$$\mathrm{C_6H_5N}\!<\!\begin{matrix}\mathrm{N}\\ \| \\ \mathrm{N}\end{matrix}$$

the three nitrogen atoms being united in the form of a closed chain. The gas dissolves in water with great avidity, forming a solution which possesses strongly acid properties, and dissolves many metals, such as zinc, copper, and iron, with evolution of hydrogen gas and formation of nitrides, the metal taking the place of the liberated hydrogen. The derivation name of the gas, azoimide, is somewhat unfortunate in view of its strongly acid nature, and Prof. Curtius proposes the name "Stickstoffwasserstoffsaure." Perhaps the nearest English equivalent, open to the least objection, is hydrazoic acid—a name which will serve to recall the many analogies which this acid bears to hydrochloric and the other halogen acids.

In studying the reactions of his recently discovered hydrazine (amidogen) hydrate, $NN_2H_4 \,.\, H_2O$, Dr. Curtius found that benzoylglycolic acid, $C_6H_5CO{-}O{-}CH_2COOH$, was decomposed by two molecules of hydrazine hydrate, with elimination of water and formation of benzoylhydrazine, $C_6H_5CO{-}NH{-}NH_2$, and hydrazine acetic acid, $NH_2{-}NH{-}CH_2COOH$, in accordance with the equation—

$$\mathrm{C_6H_5CO{-}O{-}CH_2COOH+2N_2H_4=}$$
$$\mathrm{C_6H_5CO{-}NH{-}NH_2+NH_2{-}NH{-}CH_2COOH+H_2O}$$

Under the influence of nitrous acid benzoylhydrazine forms a nitroso compound,

$$\mathrm{C_6H_5CO{-}N}\!<\!\begin{matrix}\mathrm{NO}\\ \\ \mathrm{NH_2}\end{matrix}$$

which spontaneously changes into benzoyl-azo-imide,

$$\mathrm{C_6H_5CO{-}N}\!<\!\begin{matrix}\mathrm{N}\\ \| \\ \mathrm{N}\end{matrix}$$

with elimination of water.

$$\mathrm{C_6H_5CO{-}NH{-}NH_2+NO{-}OH=}$$
$$\mathrm{C_6H_5CO{-}N}\!<\!\begin{matrix}\mathrm{NO}\\ \\ \mathrm{NH_2}\end{matrix}\mathrm{+H_2O}$$

$$\mathrm{C_6H_5CO{-}N}\!<\!\begin{matrix}\mathrm{NO}\\ \\ \mathrm{NH_2}\end{matrix}\mathrm{=C_6H_5CO{-}N}\!<\!\begin{matrix}\mathrm{N}\\ \| \\ \mathrm{N}\end{matrix}\mathrm{+H_2O}$$

Benzoyl-azo-imide decomposes, upon boiling with alkalies, with formation of benzoate of the alkali and the alkaline salt of the new acid.

$$\mathrm{C_6H_5CO{-}N}\!<\!\begin{matrix}\mathrm{N}\\ \| \\ \mathrm{N}\end{matrix}\mathrm{+2NaOH}$$

$$\mathrm{=C_6H_5COONa+Na{-}N}\!<\!\begin{matrix}\mathrm{N}\\ \| \\ \mathrm{N}\end{matrix}\mathrm{+H_2O}$$

When this sodium nitride is warmed with sulphuric acid, hydrazoic acid,

$$\mathrm{H{-}N}\!<\!\begin{matrix}\mathrm{N}\\ \| \\ \mathrm{N}\end{matrix}$$

is liberated as a gas. The gas is decomposed by hot concentrated oil of vitriol; hence diluted acid requires to be employed, and the gas can thus only be collected in a moist state. HN_3 possesses a fearfully penetrating odor, producing violent catarrh, and dissolves in water with an avidity reminding one of hydrochloric acid. The solution also bears a surprising resemblance to aqueous hydrochloric acid; for, on distillation a concentrated acid first passes over, and afterward a more dilute acid of constant composition. The aqueous solution possesses the odor of the free gas, and is strongly acid to litmus. With ammonia gas, hydrazoic acid gas forms dense white fumes of the ammonium salt N_4H_4 or

$$\mathrm{NH_4{-}N}\!<\!\begin{matrix}\mathrm{N}\\ \| \\ \mathrm{N}\end{matrix}$$

a compound which is completely volatile below 100°, and which crystallizes, but not in crystals belonging to the cubic system, in this respect indicating its different constitution to ammonium chloride. The aqueous solution rapidly evolves hydrogen in contact with zinc, copper, iron, and many other metals, even when largely diluted. As in the case of hydrochloric acid, the silver and mercurous salts are insoluble in water, the others being generally readily soluble. As the acid possesses feebly reducing properties, solutions of many

of its metallic salts, the copper salt for instance, yield precipitates upon boiling of compounds of the lower oxides of the metals. The barium salt, BaN_6, crystallizes from solution in large brilliant anhydrous crystals. With silver nitrate, the aqueous solution of the acid or a soluble salt yields a precipitate closely resembling silver chloride in appearance. Silver nitride,

$$Ag-N\Big\langle\begin{matrix}N\\ \|\\ N\end{matrix}$$

does not, however, darken when exposed to light, and is further distinguished from silver chloride by its fearfully explosive properties. During the course of his description at Bremen, Prof. Curtius placed a quantity of this salt less than 0·001 gramme in weight upon an iron plate, and then touched it with a heated glass rod. A sharp and loud detonation resulted, and the plate was considerably distorted. The mercurous salt, Hg_2N_6, is likewise very explosive. The metallic salts are readily converted into ethereal salts by reacting upon them with the haloid ethers. The phenyl salt thus prepared,

$$C_6H_5N\Big\langle\begin{matrix}N\\ \|\\ N\end{matrix}$$

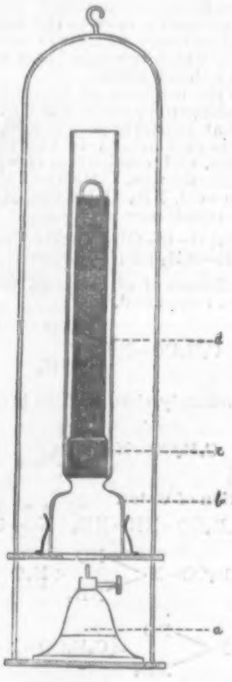
is in every way identical with the diazobenzene imide, so long ago prepared by Griess. A. E. TUTTON.

A LECTURE EXPERIMENT.

By SAVILLE SHAW, F.C.S.

THE following slight modification of a well known lecture experiment may possibly prove of service to some of your readers.

The ordinary forms of apparatus for illustrating the indestructibility of matter by the increase in weight of a burning candle have the disadvantage either of requiring the use of an aspirator, which is apt to draw



the student's attention from the more essential part of the experiment, or in the modification, where the chimney itself contains the absorbing material, the draught is often uncertain, and a deposit of soot liable to occur and choke up the spaces between the lumps of soda lime and caustic soda used.

Both these inconveniences are obviated by employing the apparatus shown in the figure, which consists of a small petroleum lamp, *a*, suspended in a wire framework beneath an ordinary lamp chimney, *b*, sufficient space being left to allow of the lamp being lighted without removal. The chimney contains a coil of coarse copper gauze, *c*. In the lower part of the narrow portion above this is placed a rather open roll of iron gauze, *d*, provided with a handle of bent wire to facilitate its withdrawal, the roll being coated with caustic soda. The covering of the gauze is easily performed either by dipping it in molten caustic contained in a nickel basin, or by ladling the melted substance over it.

The chimney may be removed from the apparatus and both ends closed by corks, enabling it to be used repeatedly without renewal. The gain in weight in three or four minutes amounts to about one grm., sufficient to show very appreciably on even a coarse lecture balance.

The Durham College of Science, Newcastle-on-Tyne.
—*Chem. News.*

ON THE ACTION OF LIGHT ON CHLORINE WATER.

IT is frequently assumed that when an aqueous solution of chlorine is exposed to light, the whole of the chlorine unites with the hydrogen of the water, setting free an equivalent quantity of oxygen. Pedler has investigated this reaction, using the sunlight of Calcutta to effect it. He finds that chlorine and water have comparatively little action on each other, even in tropical sunlight, when the number of water molecules is not more than one hundred times the number of chlorine molecules. When the number of water molecules is 150 times that of the chlorine molecules, the action may reach 50 per cent. of that actually possible. And even when it reaches 400 times, the reaction, while more rapid, reaches only four fifths of the possible amount. In ordinary chlorine water, saturated at 30°, there is about 0·5566 gramme of chlorine in 100 c. c. of water; or about 708 molecules of water to each molecule of chlorine. So that with such a solution, the decomposition may be expected to be both more rapid and more complete. Experiments with this solution show that in full sunlight the main reaction which takes place is that represented by the equation $(H_2O)_2+(Cl_2)_2=(HCl)_4+O_2$; while in feeble diffused light, the reaction at first is probably $H_2O+Cl_2=HCl+HClO$; this hypochlorous acid being in its turn decomposed by light and yielding chloric acid. So that the final reaction is $(Cl_2)_4+(H_2O)_4=(HCl)_7+HClO_3+O$. Hence the action of chlorine on water is, in its first stages at least, quite similar to that of chlorine on cold dilute solutions of potassium or sodium hydrate. In its second stage, the action of chlorine on water is similar to its action on hot concentrated solutions of these hydrates.—*J. Chem. Soc.*

FLUORINE AND CARBON.

MOISSAN has observed that fluorine and carbon combine with great energy even at ordinary temperatures. Lampblack, purified and dry, becomes incandescent at once in fluorine, and wood charcoal takes fire in it spontaneously. Denser forms become incandescent in fluorine only on heating to 50° or 100°. Graphite from cast iron unites with fluorine below redness, and Ceylon graphite and gas carbon at a red heat. If the carbon be in excess, and the temperature be not allowed to rise too high, the product is carbon tetrafluoride CF_4, a colorless gas liquefying at 10° under a pressure of five atmospheres. In contact with an alcoholic solution of potassium hydrate, it yields potassium fluoride and carbonate. It is not decomposed by the electric spark and is soluble in carbon tetrachloride, alcohol and benzene. At a red heat, the action of fluorine on carbon yields a gaseous carbon fluoride which is not absorbed by alcoholic potash and is almost insoluble in water, although it is dissolved by alcohol.—*J. Chem. Soc.*

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

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